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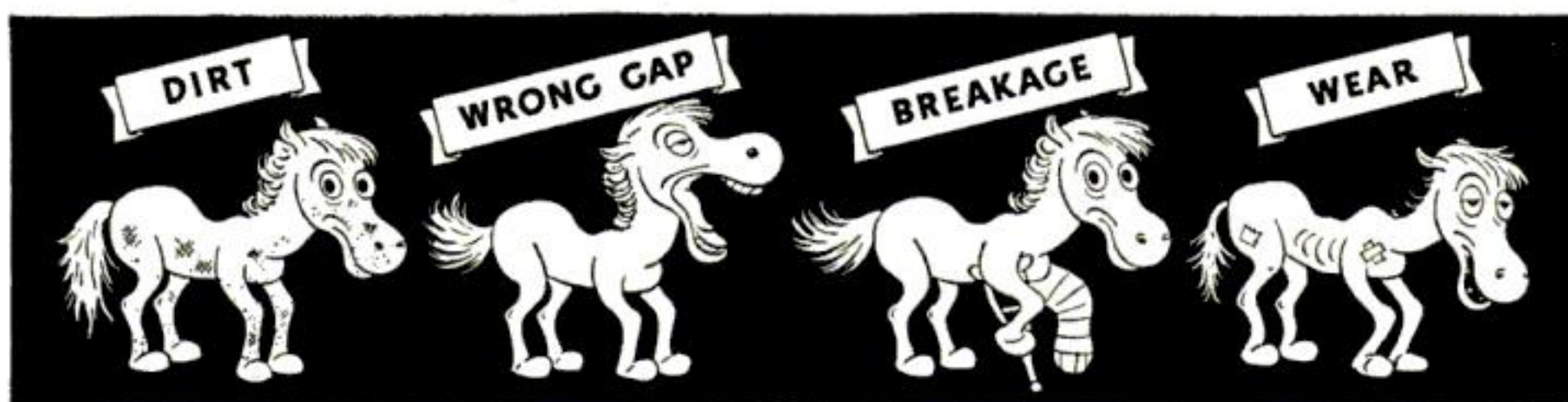
Three magazines in one

AUTOMOBILES • HOME & SHOP • MECHANICS



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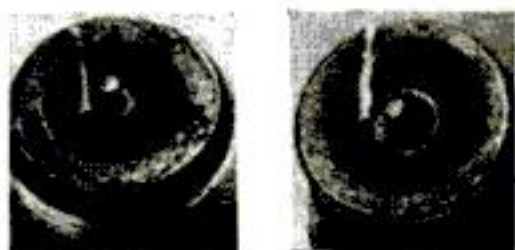
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Founded *Monthly* 1872

Mechanics & Handicraft

VOLUME 137—NUMBER 6

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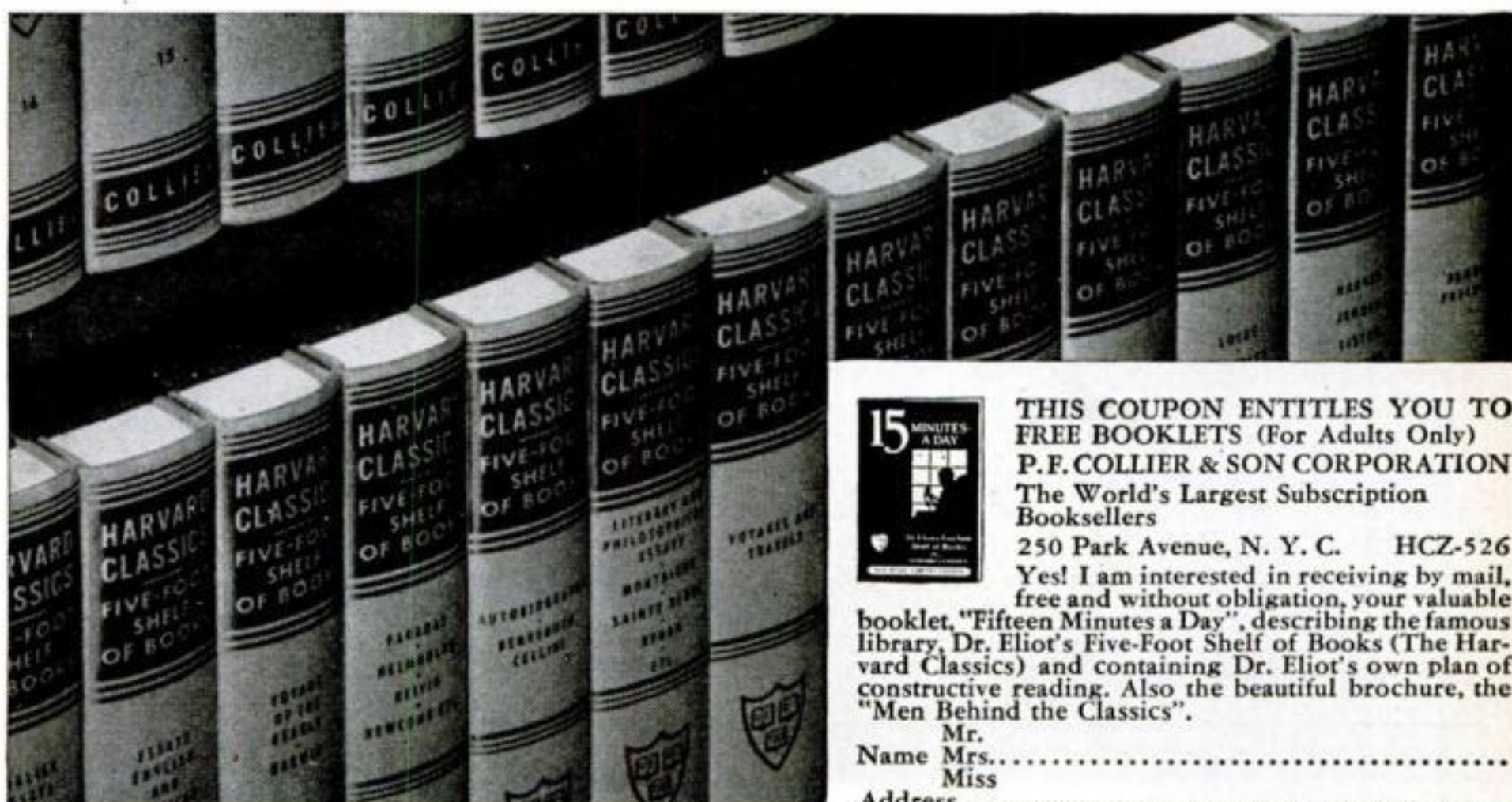
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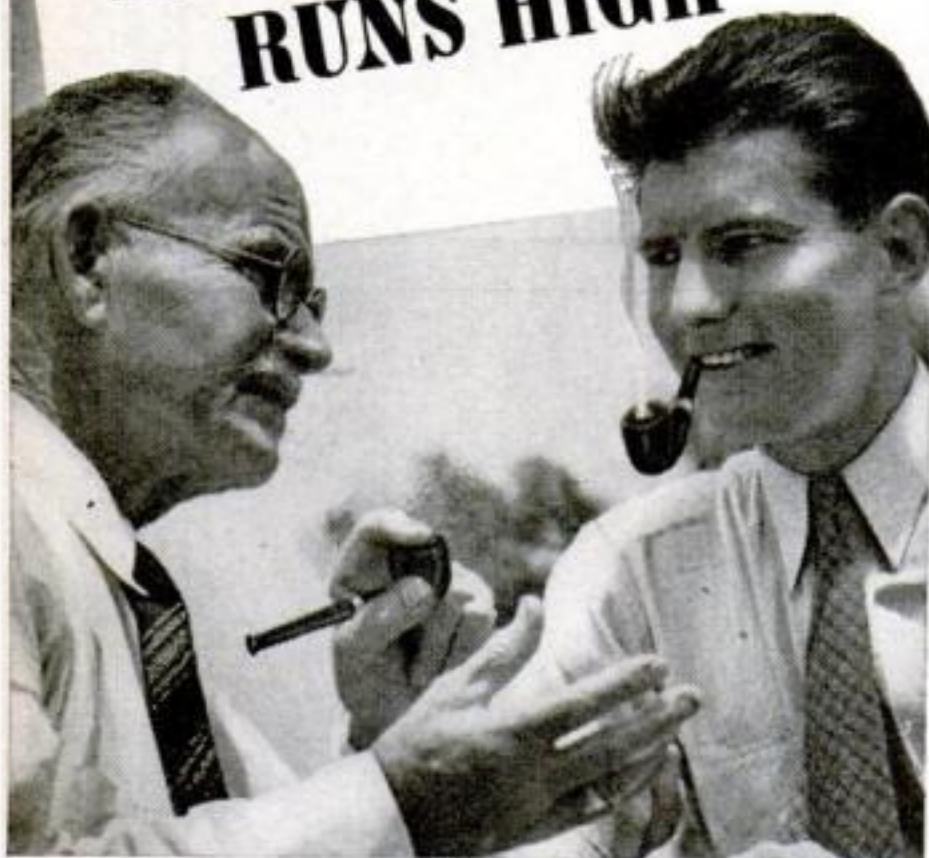
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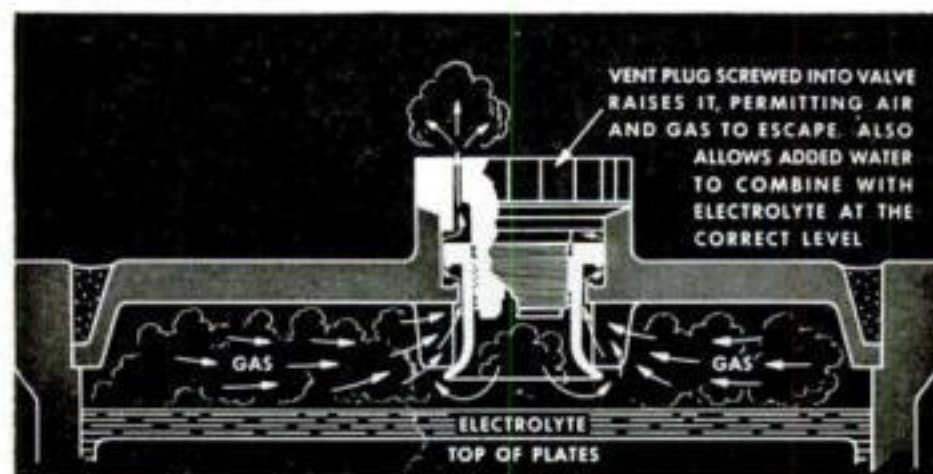
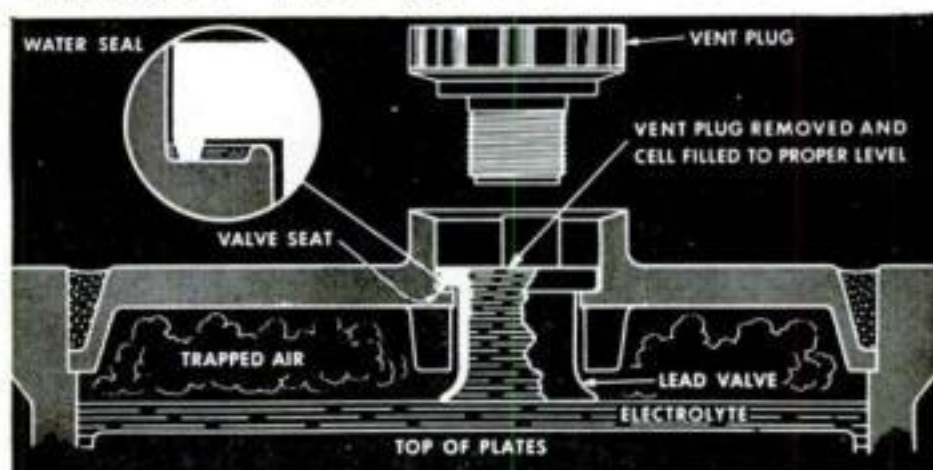


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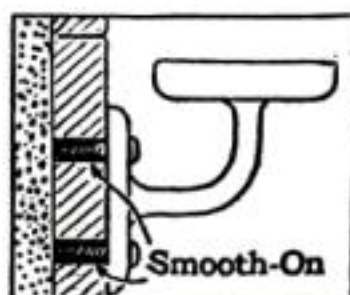
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THIS WRETCHED PAY?

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No need here to recite those hardships—though in justice to him it is only fair to say that on four separate occasions he had *almost* enrolled . . . and that on each occasion he had postponed action because of some unexpected reverse seemingly beyond his power to avoid.

"For five months now," so he wrote, "I have been 'on vacation.' Not a chance to take a course now—according to my carefully laid out and conscientiously followed program . . .

"But—supposing I had *chucked* that program at any time in the last 10 years? Supposing I had enrolled, in the face of seeming disaster, even though I had had to borrow the money to do it? Supposing even that I had enrolled only five months ago, at the beginning of my enforced vacation? In all likelihood I could have mastered the training by now. Or I might in the meanwhile have found a congenial and profitable position, thanks

LASALLE EXTENSION UNIVERSITY

A Correspondence Institution

Dept. 1283-R

Chicago, Illinois

I would like to have your special booklet—without any cost or obligation to me—about my opportunities and your success training in the business field I have checked.

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☐ Higher Accountancy
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☐ Effective Speaking
☐ Stenotypy

to my increased knowledge. As it is, for all I know, there may be another five months without any position . . . with all sorts of dim prospects . . . and meanwhile I am getting older . . .

"*That settles it! To blaze with further procrastination! To thunderation with my financial program! I've borrowed the money, and I'll borrow some more . . . but I'll do something with my time! This year is going to see a big change in my affairs—and right here is where we start!*"

Send for Free Booklet

These are searching times—and wise is the man who takes full measure of his competition . . . gets the special training that he needs . . . and thus commands the unfolding opportunities of our new-day business world.

If you need to be *convinced* of those opportunities, forget that you ever read this message. For those opportunities are not for you . . .

But if you are determined to be out in front when men are picked for leadership one year, two years, ten years from now—do not, on your life, risk a day's delay.

Below is a coupon. It will bring you—without cost—books that have led to increased earnings running into many thousands of dollars! Men of action—*hundreds of them*—will use this coupon for their personal advancement. Be one of those men who will steadily win their way to the better-salaried positions.



Ask for one of these booklets—or a similar one on your own field of business. They are FREE!

Name _____ Age _____

Position _____ Address _____

Our Readers Say



Now He Has a Shop of His Own, He's Going To Catch Up

BELIEVE it or not, I have been a reader of POPULAR SCIENCE MONTHLY for about thirty years—not every issue, of course, but steady when I was located where I could get it. I have nearly every issue for the last eight or ten years and now, at long last, I have a little shop and am going to make many of the things described in those old numbers. Many times I've wanted to write and say

GOSH, WHERE'LL I BEGIN?



what a swell magazine I thought it was, especially when I read some of the letters in "Our Readers Say" from fellows who wanted you to change the entire magazine to suit their one tiny whim. Often I wondered why they didn't buy a book devoted to their particular likes. You've made a success of the magazine as it

is and has been, yet there is always some one trying to tell you how to run it; chances are, they couldn't run a peanut stand and make a go of it. So I says, says I, keep her the way she is—and more power to you!—J. P. T., Leavenworth, Wash.

Before Long, We'll Be Afraid To Go into the Kitchen

IN A recent issue, one of your readers told of an experience with an exploding pepper shaker. Here is another mystery that almost parallels his case: We were preparing to go on an outing and had packed several things to take along, including a glass jar of ground coffee. It rained, as it usually does, so we were spending our time at home when we heard a noise like glass breaking in the kitchen. Investigation showed that the top of the coffee jar had blown off. The temperature in the room was about fifty-five degrees and the temperature of the ground coffee was normal. The lid was not too tight, and the jar was not in a draft. I wonder whether any of your readers can offer an explanation for this mysterious explosion.—L. P., Huntington, Ind.



He Knows What Makes the Wheels Go 'Round—Backward

ALTHOUGH I am only fifteen years old, I happen to know the answer to the question asked by G. B., of Riffe, W. Va., about wheels that seem to turn backward in the movies. It bothered me at one time. The reason the wheels appear to go backward is that the movie camera takes one picture when the spokes are in a certain position, and when it takes the next picture another spoke is in a position slightly back of where the first spoke was before. When this is repeated many times, the spokes appear to move backward. As the wagon slows down, the camera catches the spokes in their proper positions and the wheel appears to move in the right direction.—G. M., Columbus, Ohio.

Many readers sent in letters answering G.B.'s question. We publish G.M.'s because it is so clear and simple, and so good an example of straight thinking in a fifteen-year-old.—Ed.

Physician Misses Monthly Mental Going-Over

WHAT happened to the Question Bee? Now, I have no way of knowing how dumb I really am. Better get busy and check up on me next month.—(Dr.) D.W.K., Seattle, Wash.

For a real mental test, we suggest that the Doc try thinking up some questions these birds can't answer.—Ed.

MY PATIENTS TELL ME HOW DUMB I AM WHEN I DUN THEM FOR BACK BILLS!



That Siamese-Twin Bike Is Still Going Strong

M. L., of Winnipeg, Canada, says that he and his cousin reached speeds approaching fifty miles an hour on a pair of bicycles hooked together. I recently made a twenty-seven-mile trip on my own bicycle, alone, in ninety-one minutes. A few days later I made the same trip with a friend, using our bikes in Siamese-twin style, and this time it took much longer. I was not loafing on the rear seat, either. One disadvantage of the two-

(Continued on page 12)



I Jumped My Pay from \$18 to \$50 a Week!

Here's how I did it

by S. J. E.
(NAME AND ADDRESS
SENT UPON REQUEST)



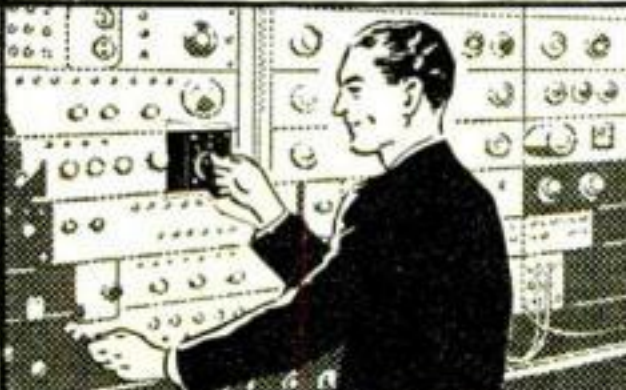
"I had an \$18 a week job in a shoe factory." He'd probably be there today if he hadn't read about the opportunities in Radio and started training at home for them.



"The training National Radio Institute gave me was so practical I was soon ready to make \$5 to \$10 a week in spare time servicing Radio sets."



"When I finished training I accepted a job as Radio serviceman. In three weeks I was made service manager at \$40 to \$50 a week, more than twice my shoe factory pay."



"Eight months later N.R.I. Graduate Service Department sent me to Station KWCR where I became Radio Operator. Now I am Radio Engineer at Station WSUI and connected with Television Station W9XK."



"N.R.I. Training took me out of a low-pay shoe factory job and put me into Radio at good pay. Radio has enjoyed a colorful past. It will enjoy an even greater future."



J. E. SMITH,
President
National Radio
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lished 25 years

Find out today how I Train You at Home to BE A RADIO TECHNICIAN

If you can't see a future in your present job, feel you'll never make much more money; if you're in a seasonal field, subject to lay offs, IT'S TIME NOW to investigate

Radio. Trained Radio Technicians make good money, and you don't have to give up your present job or leave home to learn Radio. I train you at home nights in your spare time.

Why Many Radio Technicians Make \$30, \$40, \$50 a Week

Radio broadcasting stations employ operators, technicians. Radio manufacturers employ testers, inspectors, servicemen in good-pay jobs. Radio jobbers, dealers, employ installation and servicemen. Many Radio Technicians open their own Radio sales and repair businesses and make \$30, \$40, \$50 a week. Others hold their regular jobs and make \$5 to \$10 a week fixing Radios in spare time. Automobile, Police, Aviation, Commercial Radio; Loudspeaker Systems, Electronic Devices are other fields offering opportunities for which N.R.I. gives the required knowledge of Radio, Television promises to open good jobs soon.

Many Make \$5 to \$10 a Week Extra In Spare Time While Learning

The day you enroll, I start sending you Extra Money Job Sheets—start showing you how to do Radio repair jobs. Throughout your Course I send plans and directions which have helped many make \$5 to \$10 a week extra in spare time while learning. I send special Radio equipment to conduct experiments and build circuits. This 50-50 training method makes learning at home interesting, fascinating, practical. YOU ALSO GET A MODERN, PROFESSIONAL ALL-WAVE, ALL-PURPOSE SET SERVICING INSTRUMENT to help you make money fixing Radios while learning and equip you for full time work after you graduate.

Find Out What Radio, Television Offer You—Mail Coupon

Act Today! Mail the coupon for my 64-page book, "Rich Rewards in Radio." It points out Radio's spare time and full time opportunities and those coming in Television; tells about my Course in Radio and Television; shows more than 100 letters from men I have trained, telling what they are doing and earning. Read my money back agreement. MAIL COUPON in an envelope or paste on a penny postcard—NOW!

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Washington, D. C.

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National Radio Institute, Washington, D. C.

Mail me FREE, without obligation, your 64-page book, "Rich Rewards in Radio." (No salesman will call. Write plainly.)

Age.....

Name.....

Address.....

City.....State.....

Our Readers Say (CONTINUED)

bicycle plan is that the rear man must use his brake first, and he cannot see ahead very well.—D.D., Toledo, Ohio.

Introducing Si, the Big Guy Who Draws the "Little Guys"

WITH the changes you have made in the size and make-up of P.S.M., I think it beats any other scientific magazine on the market, regardless of price. I am offering no sug-



gestions for improvement, but there is one thing I would like to mention. I get a big kick out of the "little guys" that decorate the pages of "Our Readers Say," and I think the artist who draws them should come out of hiding and take a bow! —A.C., Jr., La Monte, Mo.

When he is not showing you the insides of some complicated gadget like the Palomar telescope (page 107), B. G. Seielstad gets a kick out of drawing the "little guys." Such is his modesty that the accompanying self-portrait doesn't do him justice.—Ed.

That Gun Cabinet Hit the Mark with This Michigan Trapper

THAT "Gun Cabinet of Knotty Pine" described in your September issue works fine in my trapping cabin. Put more of that kind of stuff in P.S.M.!—L.W.F., Gaines, Mich.

A Question of Gravity Has Him All Balled Up

SUPPOSE you had two metal balls, and the larger one was hollow so that the smaller one would go inside it. Suppose the smaller ball could be placed in such a position that their centers of gravity coincided. Since the force of gravitational attraction between them varies inversely as the square of the distance between their centers of gravity, the force of attraction would be practically infinite and the smaller ball would be supported in mid-air. This does not seem reasonable to me, so could one of your readers point out my mistake in reasoning?—R.T.S., Kirkland Lake, Ont., Canada.

HOW DO THESE GUYS THINK UP PROBLEMS THEY CAN'T SOLVE?



(Continued on page 14)

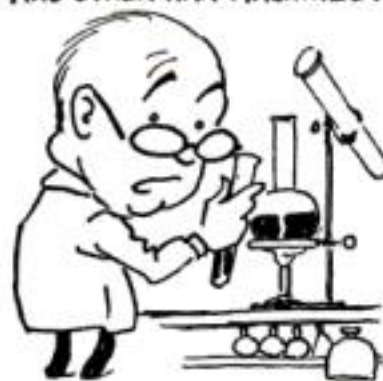
Ship-Model Builder Wants More Old-Time Vessels

IN THE past, I have greatly enjoyed building your ship models such as the *Malek Adhel* and many others. I know that Captain McCann has passed on, but don't you think that these models of old-time ships should be continued?—M.E., Boston, Mass.

What We Need, He Believes, Is To Learn How To Live

How many of your readers would be interested in a series of articles to comprise a course in inorganic chemistry and qualitative analysis? Also, a similar series on microscopy and elementary bacteriology? I certainly think these would be better than all

IT TAKES CHEMISTS AND SUCH TO MAKE EXPLOSIVES AND OTHER WAR MACHINES!



the articles and pictures on war and its adjuncts which appear so promiscuously in all magazines and newspapers now. Such a series of articles might start some yet unknown person on the road to the discovery of a cure for cancer, a new drug to combat tuberculosis, new methods of fighting

industrial diseases. Wouldn't that be better than all the articles on new bombs, dive bombers, death rays (?) and so on? What this world needs is more and better schools and teachers, hospitals and doctors, laboratories and scientists, to help us to learn and live, not to die.—H.W.F., Bridgewater, Mass.

A Plea for a Department on Doing Nothing Efficiently

YOUR new subject-matter grouping of pages, with the convenient index, is another step toward perfection. It is observed, also, that "this month brings you (us) a new, greatly enlarged Automobile Department . . ." Let 'er come! I suggest another improvement by supplementing "Our Readers Say" with a department of "Occupation for Nothing-To-Do People: How To Do Nothing Efficiently." By the way, I read somewhere that during the last six years "C.C.C. boys" have built 44,000 bridges, 110,000 miles

ANYWAY, HE CAN'T SAY THAT WE C.C.C. BOYS HAVE NOTHING TO DO!



**THEY
WHISTLE**

**THEY'RE
ALL-
ELECTRIC**

**THEY
BUZZ
WITH ACTION**



Built with No. 8 1/2
Erector Set



Built with No. 9 1/2
Erector Set

BOYS!

Look at that towering Erector parachute jump, with electrically illuminated top. You build it yourself. Piece by piece you fit the long gleaming girders together—attach the parachute rigging—and install the powerful Erector reversing electric engine. . . . And now for thrilling action! Blow your whistle . . . throw your engine into gear and your parachutes are hoisted up and up until they strike the release mechanism. Then, like a flash, they plummet downward—unfold—and lazily float to the ground.

Now get a load of that mighty Ferris wheel. It whistles—twinkles with light—operates in either direction at slow or high speed. You can build hundreds of spectacular, realistic mechanical marvels with one Erector set. And how the Erector electric engine makes them buzz with action! See the new Erectors at your nearest toy store. Take Dad along.

A. C. Gilbert, Founder of the Gilbert Hall of Science, the home of Erector, American Flyer Trains, Gilbert Chemistry Sets, Gilbert Microscopes and other Gilbert Scientific Toys.

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**The COLOSSAL
ALL-ELECTRIC
ERECTOR**

Our Readers Say (CONTINUED)

of roads, and 5,200,000 dams. Aren't there any C.C.C. girls? If so, what have *they* been doing all this time?—H.E., Mexico City, Mexico.

Another Solution Would Be To Motorize an Ash Tray

As a solution of the problem of smoking in a car, what would you think of a built-in ash tray in which the bottom swings out on spring

BUSINESS IS BUSINESS!



hinges when you press a button, allowing the ashes to go down a pipe and fall on the road? It seems to me that this would be better than flicking the ashes out the window and getting them back in your eye, and an improvement over the ash receivers in most cars, which can hardly be emptied without dismantling the whole

automobile.—D.J.B., Chicago, Ill.

Since P.S.M. Says So, We Must Be Wrong

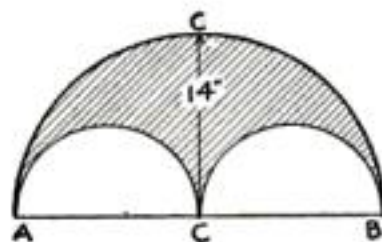
You state that Sikorsky's new helicopter was the first to make a successful vertical flight. Maybe so in North America. But look back through your files to June 1938, and you will find a photograph of a Focke-Wulfe helicopter being flown by a girl in a German beer garden. As you correctly stated, this craft was the first to stay in the air for any length of time, which an Italian one failed to do. It is much more compact than its predecessors or the Sikorsky machine.—B.G., Halifax, N.S., Canada.

B. G. is right. Some day we'll get around to reading this magazine of ours.—Ed.

This Problem in Circles Should Be Easy as Pi

HERE'S a math problem to help you along. All the arcs in the figure are semicircles.

The line CD is erected perpendicular to the diameter of the large circle, AB, at the point of tangency of the two small semicircles. The point D is any point on the diameter AB. What is the area of the shaded portion of the figure? Use pi equal to $22/7$. CD equals fourteen inches.—R.S.K., Chicago, Ill.



WHAT IS THE AREA OF THE SHADED PORTION?

Gus Wilson Helps Start a Puerto Rico Workshop

WHEN I sent Martin Bunn a little information to use in his "Gus and Joe" stories, I was not expecting to earn any money by it. However, I am very grateful for the five-dollar check, for it started my home workshop. I used it for the down payment on a bench saw and motor. My regular job is as a power-plant operator, and on the side I act as auto mechanic for neighbors and friends. Once in a while I get a queer problem. The other day I got one that had me stumped. Perhaps you will let me tell you about it some time, but I am not expecting to get paid for it. Maybe it would show somebody, somewhere, how to cure this same trouble. Wishing Gus Wilson carloads of good luck and many years of fruitful life. P. S.: Is Gus married or a bachelor?—R.F., Isabela, Puerto Rico.

Gus is a confirmed bachelor. As he once remarked, "Cars are cranky enough, but after about twenty years of study a fellow can sort of figure what one of them is going to do next. As for women . . ."—Ed.

Here's One Trick the Enemy Would See Through at Once

WOULDN'T it be a help to the United States, "if" we got into a war, to make planes out of transparent plastic? Then, when you went to bomb the enemy, they could hear the motors going, but they would see right through the planes. The motors, controls, and bombs would be hard to see up in the sky.—W.H., Miami, Fla.

THAT WAS EITHER TRIED OR AT LEAST SUGGESTED DURING WORLD WAR 1



We Got Off on the Wrong Foot With That Corn Razor

FOR the last five or six years, I have noticed a queer instrument in my father's possession. When I inquired about it, I learned that it was a corn razor. Imagine my surprise when I saw it described as a new device in your September issue! I don't mean to knock the product, because it serves its purpose well. What puzzles me is how it happens to appear as something new. The one you illustrate is the identical twin of the one my father uses faithfully.—J.M., White Plains, N.Y.

Apparently, the razor described in our September issue was not a brand-new invention but an improved product.—Ed.

"IT WAS LIGHT IN A WILDERNESS OF DARKNESS TO ME"

● "I was stuck. A wife and three kiddies — and the same old pay envelope. I couldn't see a thing ahead except the same old grind. Then one day I read an I. C. S. ad. The coupon fascinated me. A new idea struck home — it was light in a wilderness of darkness to me! Today, because I mailed that coupon two years ago, I am a trained man — making a trained man's pay!"

Nearly fifty years ago, the International Correspondence Schools were established to provide sound educational facilities to men unable to attend resident schools. Over five million dollars has been spent in preparing textbooks and keeping them up-to-date. Today, you'll find I. C. S. graduates holding leading positions in every field of business and industry.

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Helps for the Home Owner



Applying linoleum covering to a wall. Openings for switches and other wall projections are cut out of the material, as in using wall paper

Wall Covering of Linoleum Now Available

LINOLEUM, long used for floor coverings, is now being employed for covering the walls of bathrooms, kitchens, and playrooms, with a wide selection of patterns and colors available. The covering is exceptionally easy to apply. A strong adhesive base is first brushed onto the wall to be surfaced, and the linoleum then rolled into place over it, as shown in the photograph at the left. Openings for light switches and other wall projections are cut out with a sharp, heavy knife. Being completely waterproof, linoleum walls can be thoroughly scrubbed and washed when they become soiled, without any possibility of damage to the surface. Furthermore, since they are fadeproof, they are not affected by exposure to strong sunlight. The material makes decorative effects possible in rooms where wall paper would not be practical.

Single Unit Combines Blowtorch and Soldering Iron

BLOWTORCH and soldering iron are combined in one unit now available to home repairmen. Either gasoline, benzine, or denatured alcohol may be used as fuel for the blowtorch, whose concentrated flame heats up the unit's soldering point within three minutes. The torch-regulating valve, at the end of the unit, serves also as a stand for the soldering iron when it is not in use.



Concentrated flame from the blowtorch in the handle heats the soldering-iron point. The flame-regulating valve serves as the rest



SCALE MODELS

Lionel train outfits with engine, tender, cars, track and transformer from \$7.95.

GREATEST THRILL ON WHEELS!



BASCULE BRIDGE

Opens by remote control, automatically halting approaching train at the edge of bridge.



LOG LOADER

Electric elevator lifts logs for loading cars by remote control.



ENGINE WHISTLES

Any whistle of the Official Railway Code — by remote control.



New Engines! New Cars! New Scale Model Realism!

Send at once for a copy of the new 1940 Lionel Catalog and have a look at the greatest array of scale model railroading equipment Lionel has ever built. 64 full-color pages of railroading fun, thrills and excitement.

Now, Two Trains On One Track

Read about Magic Electrol, the sensational Lionel invention that enables two trains to operate on the same track circuit, with each independently controlled. See pictures of new freight cars. Examine details of electro-magnetic couplers and electrically actuated cars that unload by remote control. Don't delay. Mail coupon below.



MAGNET CRANE

Greatest accessory of 1940. Lifts steel beams by magnetism and revolves electrically.



BLOCK SIGNAL

New Lionel signal prevents collision when two trains operate on the same track layout. Electric operation.

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Scale Model Headquarters

THE LIONEL CORPORATION, Dept. 71,
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Enclosed is 10 cents to cover postage and handling.
Please send a copy of the new Lionel Catalog at once.

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DECEMBER, 1940

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17



Portable Electric Repair Kit Holds Tools, Wires, Parts

ELECTRICAL work around the home should be made easier by the portable wiring kit pictured above. Spools for wire are mounted on top of the metal kit box, which contains a drawer of compartments for screws, insulating materials, and other small wiring parts. A twelve-inch rule is marked along the edge of the case just above the drawer.



Circular-Spray Shower Head Takes Less Water Pressure

BECAUSE it requires less water pressure to provide an adequate soft spray, a new shower head effects a saving in the amount of water used. No small holes are used, water squirting out around the sides of the shower-head face, in a controlled circular stream. A ball joint allows the head to be adjusted to various angles.

Rubber Molding Seals Edges of Built-In Bathtubs

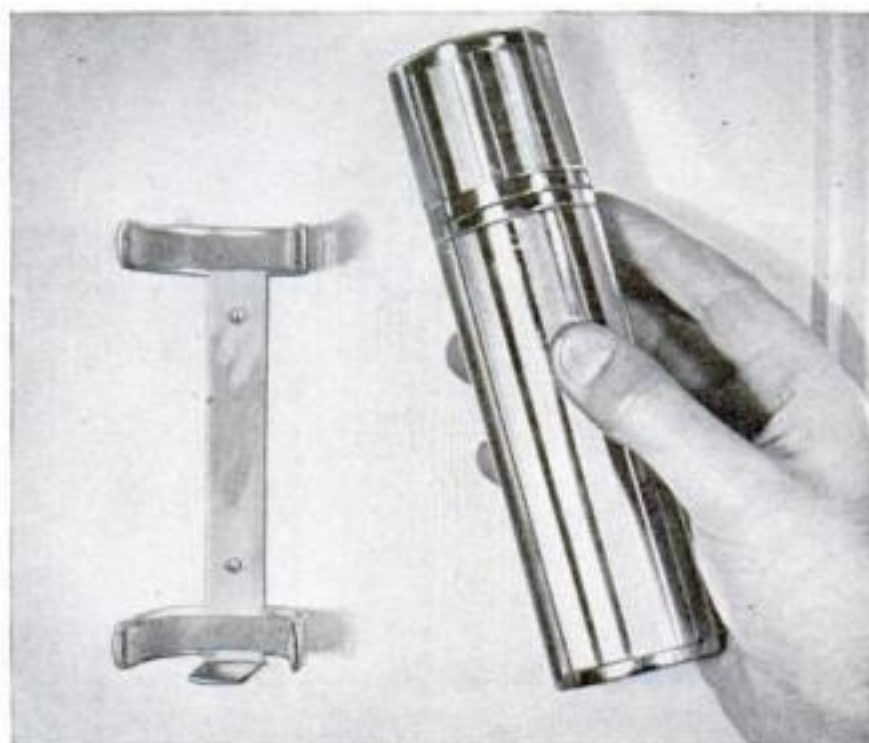
PERMANENT, water-tight, and decorative, rubber molding in strip form is now marketed for sealing the joint between a built-in bathtub and the adjacent wall. The molding, which is flexible to follow the contour of the tub, is made of sponge rubber faced with solid rubber that is not affected by soap or hot water.



Built-in tub with rubber molding along the wall joints. Inset shows how the material is applied

Midget Fire Extinguisher Is Handy for Home or Car

A FLASH-LIGHT-SIZE fire extinguisher only six inches long is now offered to home owners. Sold complete with a tubular case and wall bracket, the unit has put out small oil, kerosene, and gasoline fires within fifteen seconds, in tests. Breaking a metal tip puts the extinguisher in operation.



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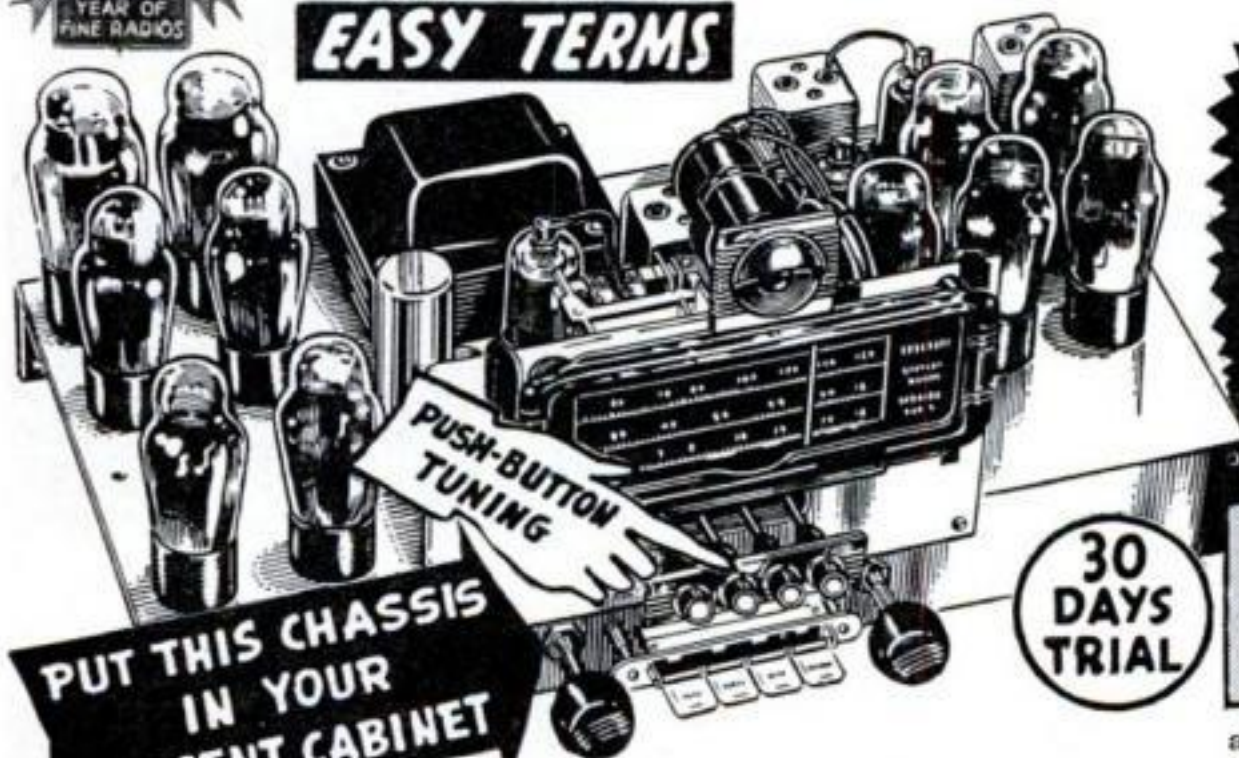
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With the Inventors

SHELLING peas should be a simple matter for the housewife who uses a novel kitchen unit devised by Anthony Flanagan, of Ardmore, Pa. To use the device, the housewife slices off the end of a pea pod with the sharp blade mounted on the unit, and then slides the pod along a metal lip so that a sharp



metal point slits the pod open and dislodges the peas. The peas then roll down through a metal tube into a cooking pot, and the empty pod is tossed aside . . . If an inventor asks the Patent Office whether his idea is new or novel, before he applies for a patent on it, they will refuse to answer his query. However, the Patent Office is open to him, his attorney, or his agent,

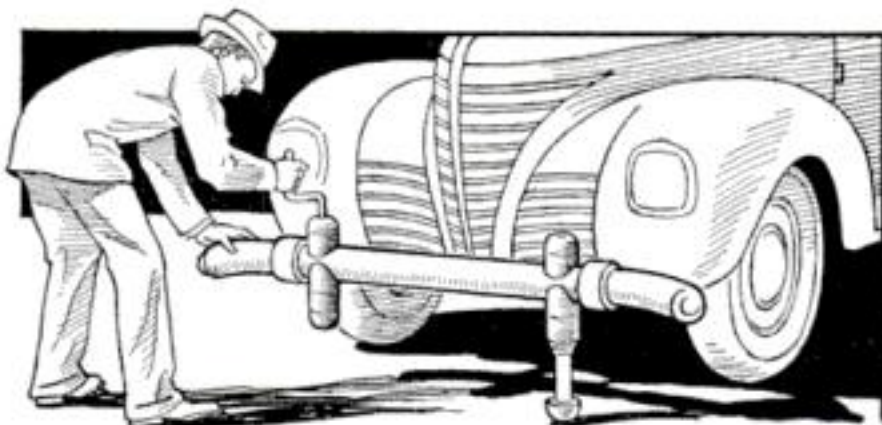
and patent records may be thoroughly searched so that he may determine the novelty of the idea for himself . . . A DOLL that can be made to sing or to talk in complete sentences is the development of a South American inventor, Pedro Strauss, of Caracas, Venezuela. A mechanism within the body of the doll utilizes a sound strip to reproduce recorded words and direct them out through the mouth of the doll. Movement of the sound strip is accomplished by means of a spring motor wound by weights that are



moved when the doll is tilted to a horizontal position or turned upside down, and then returned to a normal vertical position. Several different recordings of words, phrases, or musical sounds can be recorded on the same sound strip, it is said . . . PLANT PATENTS

(Continued on page 22)

have been issued since 1930, but only about 400 have been granted to date . . . AN AUTOMOTIVE IMPROVEMENT worked out by Albert C. Hoecker, of St. Louis, Mo., combines a bumper with two jacks for raising the car to change tires or make repairs beneath the chassis. The jacks are installed in vertical



members built into the bumper, and are operated by means of a crank that fits into the top of each unit. When the crank is turned, a tubular leg is screwed down to meet the ground and raise the car up off its wheels. Bumper jacks can be installed at both the front and back ends of the car so that the vehicle may be raised completely off the ground . . . YOU'VE SAID A MOUTHFUL when you quote the title of patent 2,192,015: "Polymerization and Condensation Process Catalyzed by Means of Dihydroxyfluoboric Acid and Dihydroxyfluoboric Acid-Boron Fluoride Addition Compounds" . . .

AN INCONSPICUOUS and efficient hearing aid for the deaf, built into a pair of eyeglasses, is the invention of John Walter Cox, of Berkeley, Calif., who has assigned the patent on the device to the Radio Corporation of America. The sound-reproducing mechanism, of the bone-conduction type, is installed

at the broad tip of the eyeglass bows, so that it presses against the bone back of the ear. The lenses, which may be made of plain glass, or ground to correct a visual defect, serve as a diaphragm or pick-up element in place of the small microphone used with



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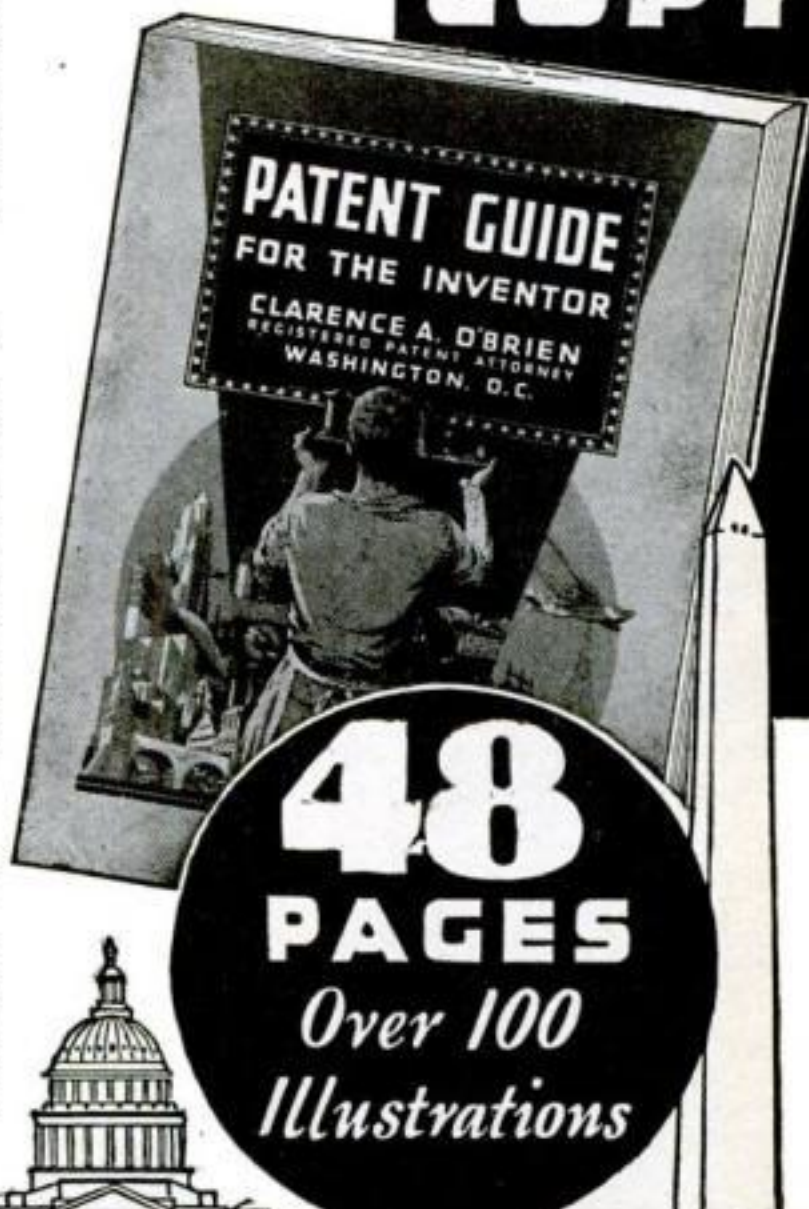
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With the Inventors

(Continued from page 20)

conventional hearing aids. Tiny batteries that operate the device are installed within the bows of the glasses . . . To PROVIDE SKIERS with a way to obtain better control on downhill runs, Hans Thirring, an Austrian inventor, has patented the odd ski sails shown in the illustration. Made of balloon silk, sail-



cloth, or a similar material, the sails are cut so that the lower ends can be fastened to the ankles of the skier by means of loops and elastic straps. At the upper edge, the sail is turned back to form sleeves, into which the skier places his arms. When running down an exceptionally steep slope, the skier can spread out his arms and let the wind enter the bellied sail, which then will act as a wind brake to slow him down to a safe speed. The sail may also be used as an aid in turning to one side or the other . . . ONLY TWO WHEELS are used on a roller skate patented by William



H. Decker, of Shawnee, Okla. Each skate has one rubber-tired wheel placed at the front and on the outside of the foot, and a second wheel placed at the rear and on the inside of the foot. According to the inventor, this arrangement makes it easy for the skater to change the direction of his travel, and since the wheels are rubber-tired and con-

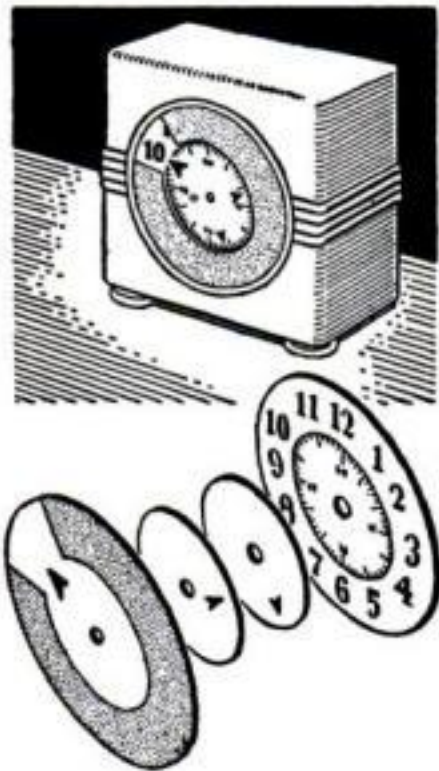
siderably larger than conventional wheels, skating over rough surfaces is possible without greatly affecting the skater's balance, or causing him to fall. The skates are steadied by a vertical steel brace which is strapped

(Continued on page 23)

With the Inventors

(Continued from page 22)

to the outside of the skater's leg . . . NATHAN HAMMER, of New York City is responsible for a novel clock which has no hands. The timepiece utilizes four dials, placed one over the other, and all moved by the same clock-work mechanism. The outside dial, transparent except for an opaque ring around the



outside that has one transparent opening, is used to indicate the hour. The second dial contains an opaque arrow, which indicates the minute, and the third dial has an opaque arrow that indicates the second. The fourth dial is marked with hour numerals around its outside rim, and minute and second markings nearer the center . . .

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practice of the U. S. Patent Office: "Whenever, during a time when the United States is at war, publication of an invention by the granting of a patent might, in the opinion of the Commissioner, be detrimental to the public safety or defense or might assist the enemy or endanger the successful prosecution of the war, he may suspend action on the application therefor" . . . NO MOTOR is required to operate an automobile turntable invented by Fred W. Jacobs, of Louisville, Ky. As the car is backed up onto the raised circular platform, its rear bumper engages a standard which is connected by means of



a cable to tension springs installed in the garage. By the time the car is in position on the turntable, enough energy has been stored in the springs to spin the platform around. Before being used again, it is returned to its original position by hand.

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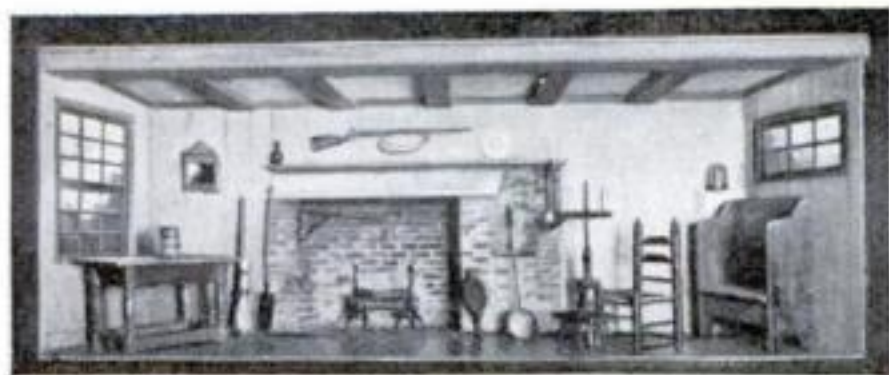
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(Continued on page 26)



Scale model of an Early Colonial kitchen assembled with Kit 13. It is 21" long, 7" high, and 5" deep

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(Continued from page 25)

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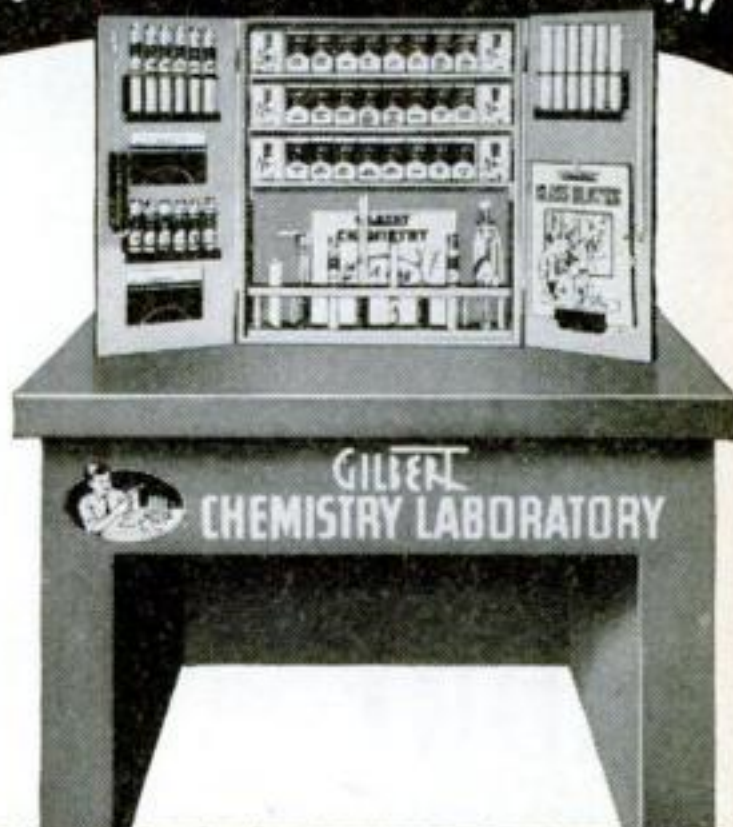


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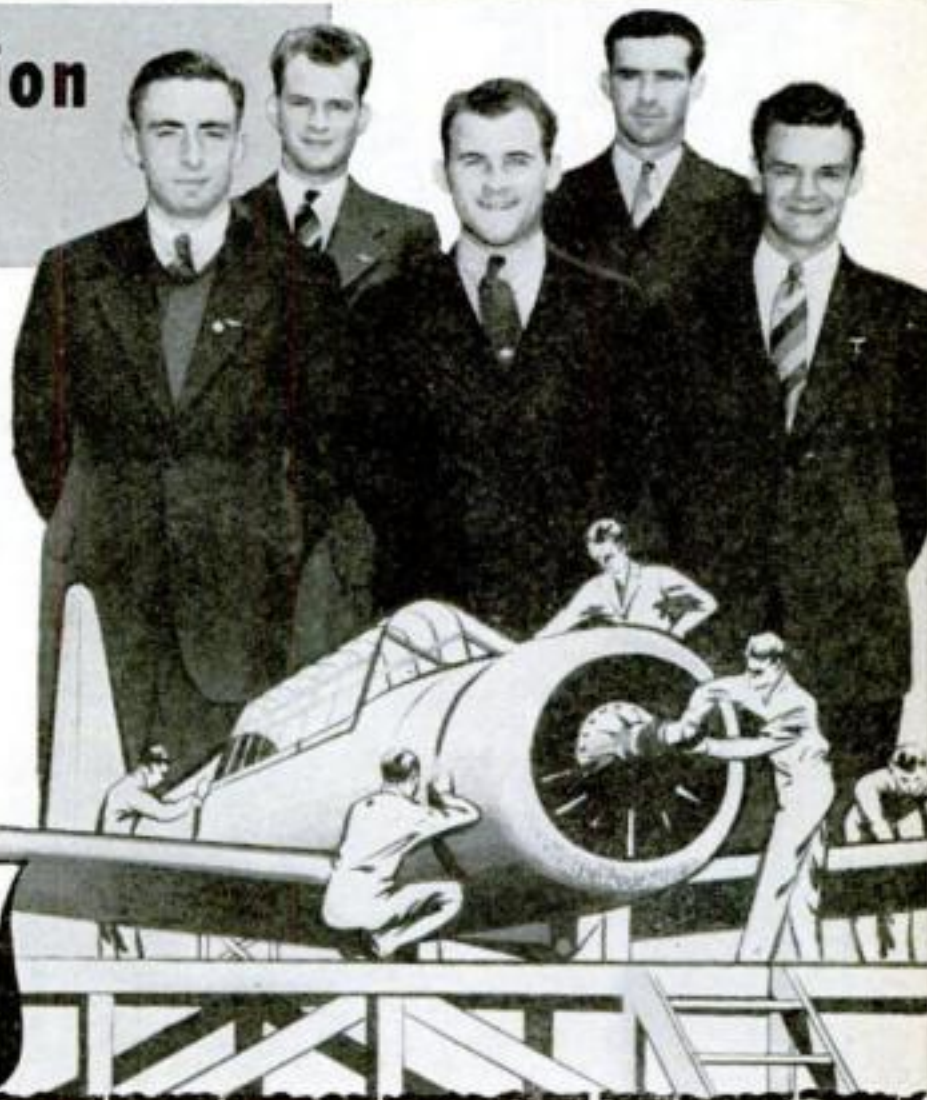
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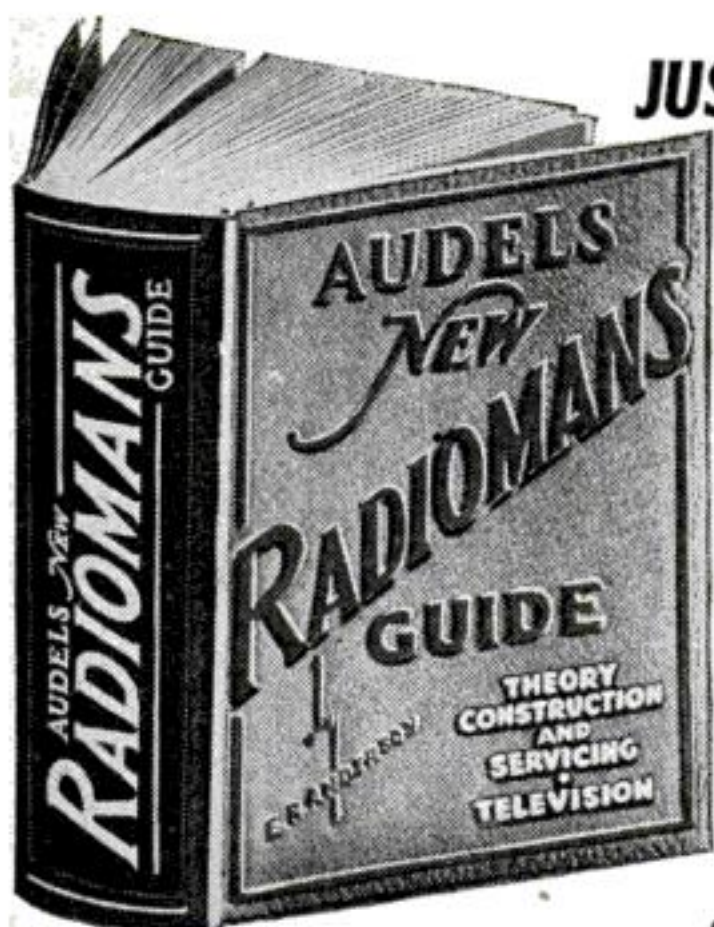
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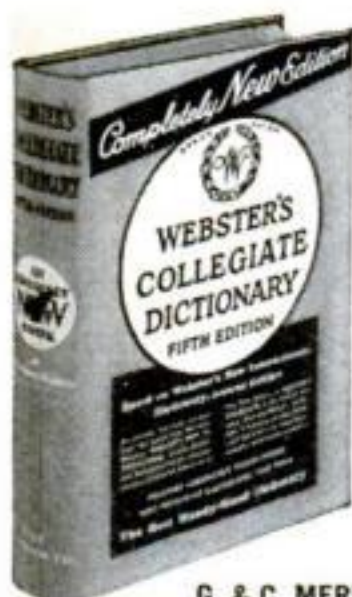
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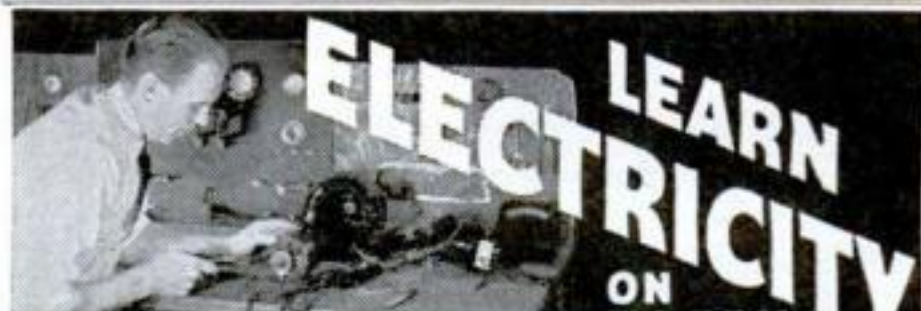
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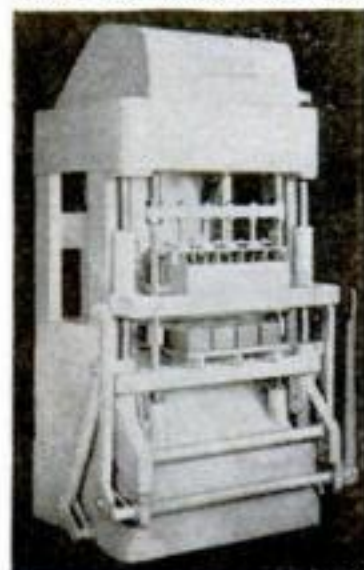
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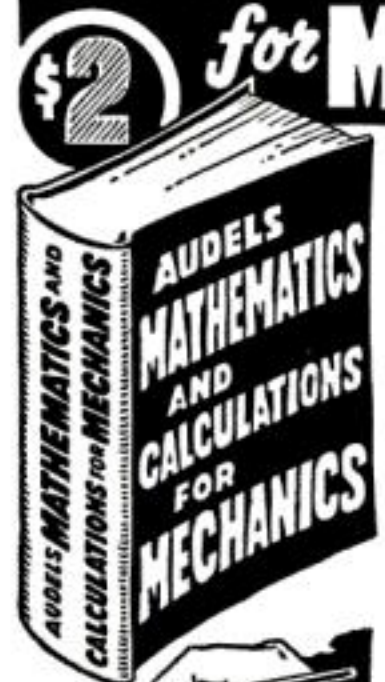


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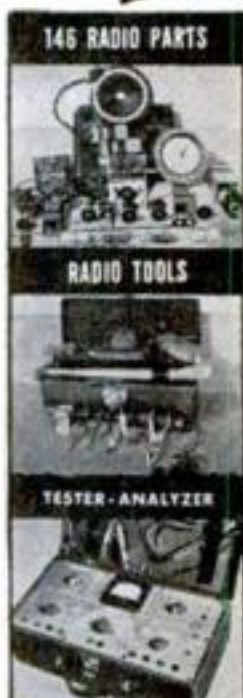
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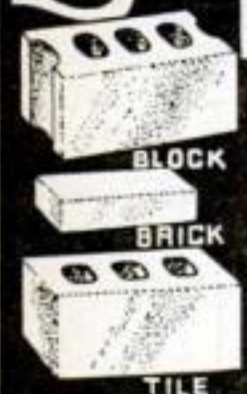
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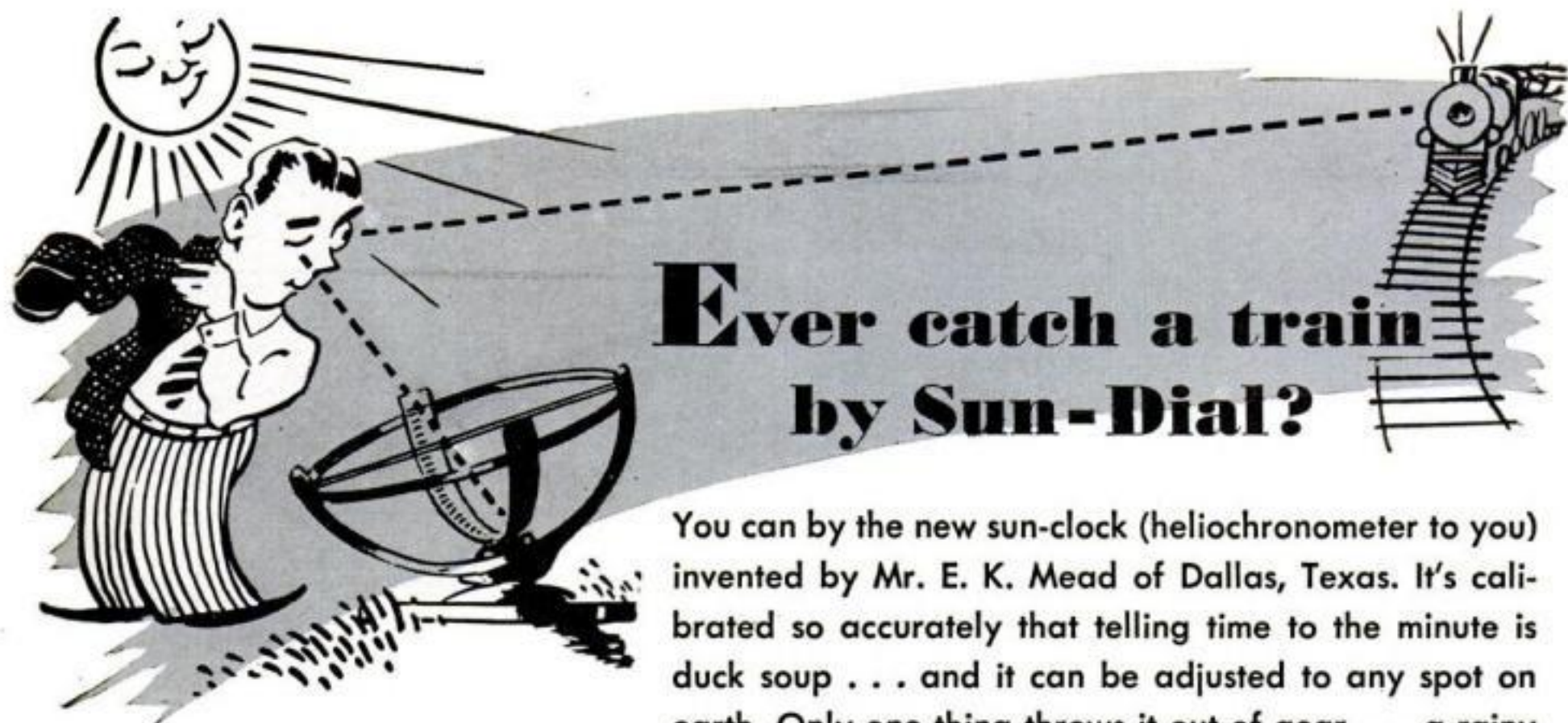
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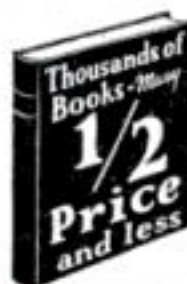
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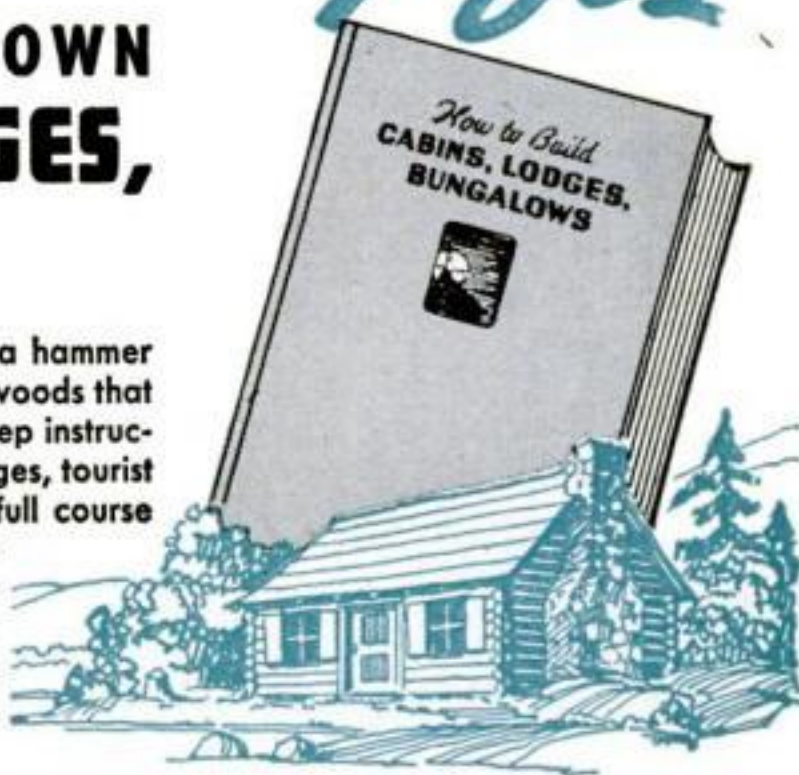
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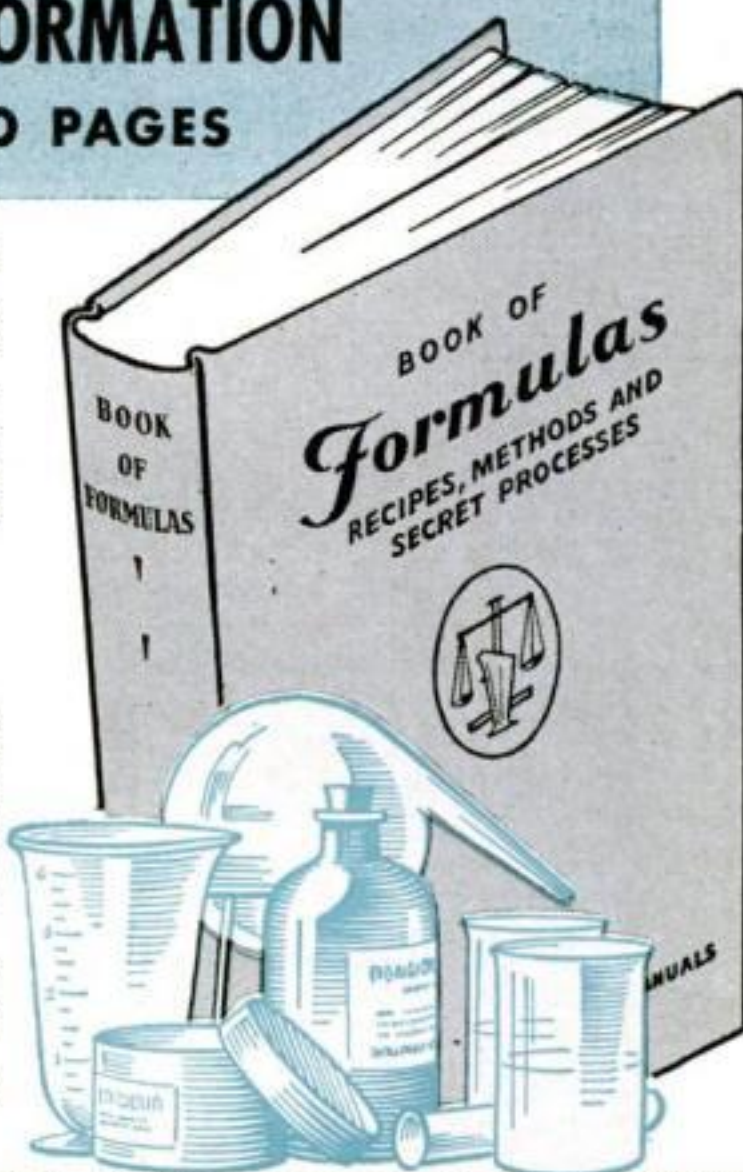
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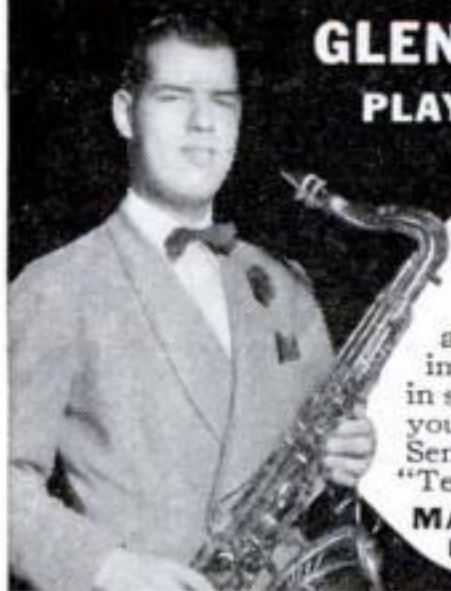
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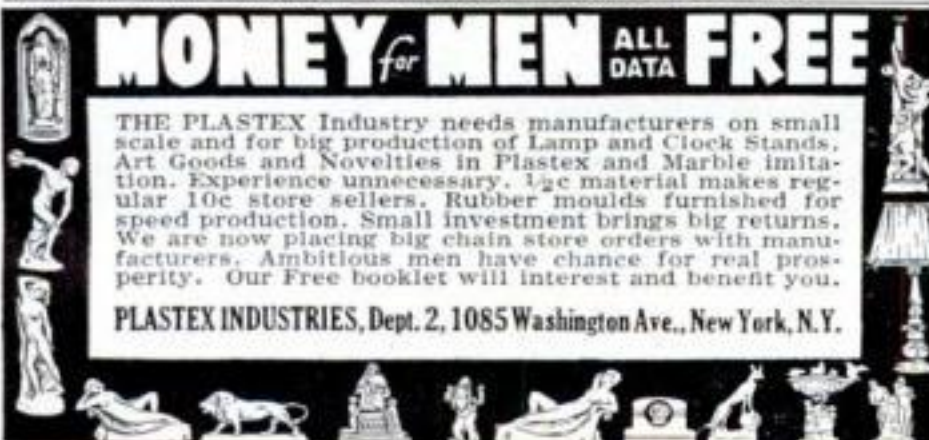
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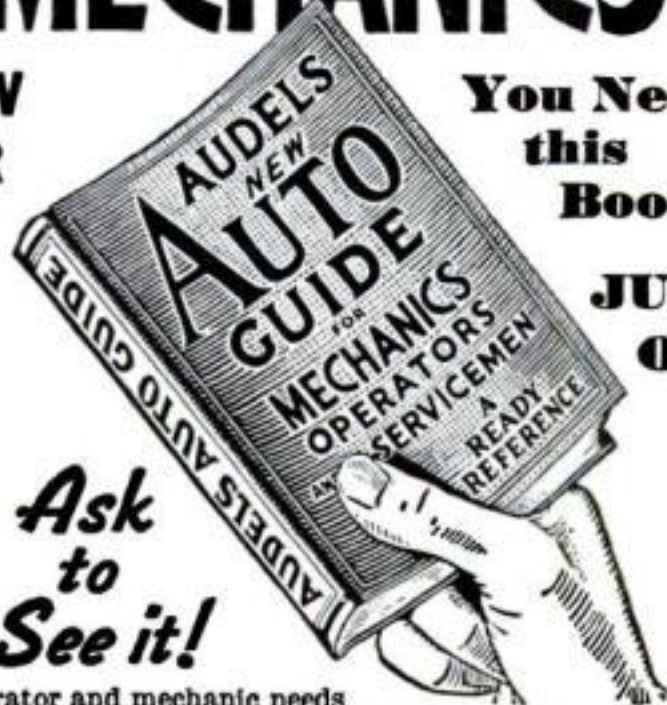
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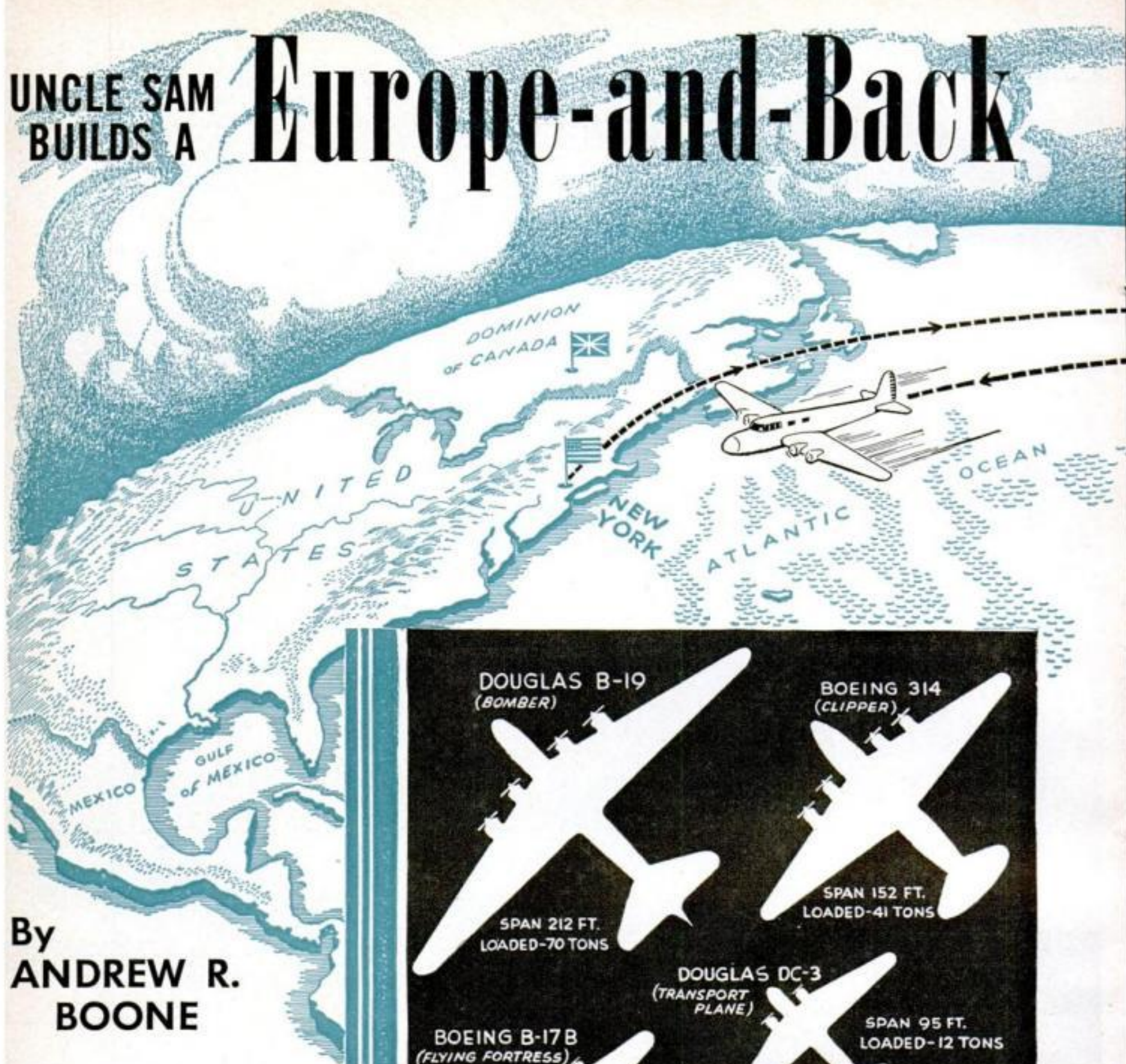
The **MAN** *of the Month*

Wealth and a famous father are two stumbling blocks in the way of success. At least that was the short-pants notion of Edward R. Stettinius, Jr. For "Little Stet," as University of Virginia classmates tagged him, swapped his college blazer for the grimy overalls of a forty-cent-an-hour General Motors laborer. And his notion must have been right, for just seven years later the motor moguls lettered "Vice-President" on his office

door. And seven years after that, the white-haired, black-browed stripling of thirty-seven startled the industrial world by becoming head of one of the largest corporations on earth, U.S. Steel. Now, at forty, he has tossed aside that \$100,000 job and is collecting his dollar a year providing the mountains of raw materials necessary to satisfy the monstrous appetites of the thousands of factories that are grinding out guns, tanks, and planes for national defense. Whether slashing red tape in Washington, or calmly discussing the health of Hereford cattle or Belgian draft horses on his Virginia farm, "Little Stet" constantly exhibits his amazing genius for getting all types of men to pull together in a common cause.

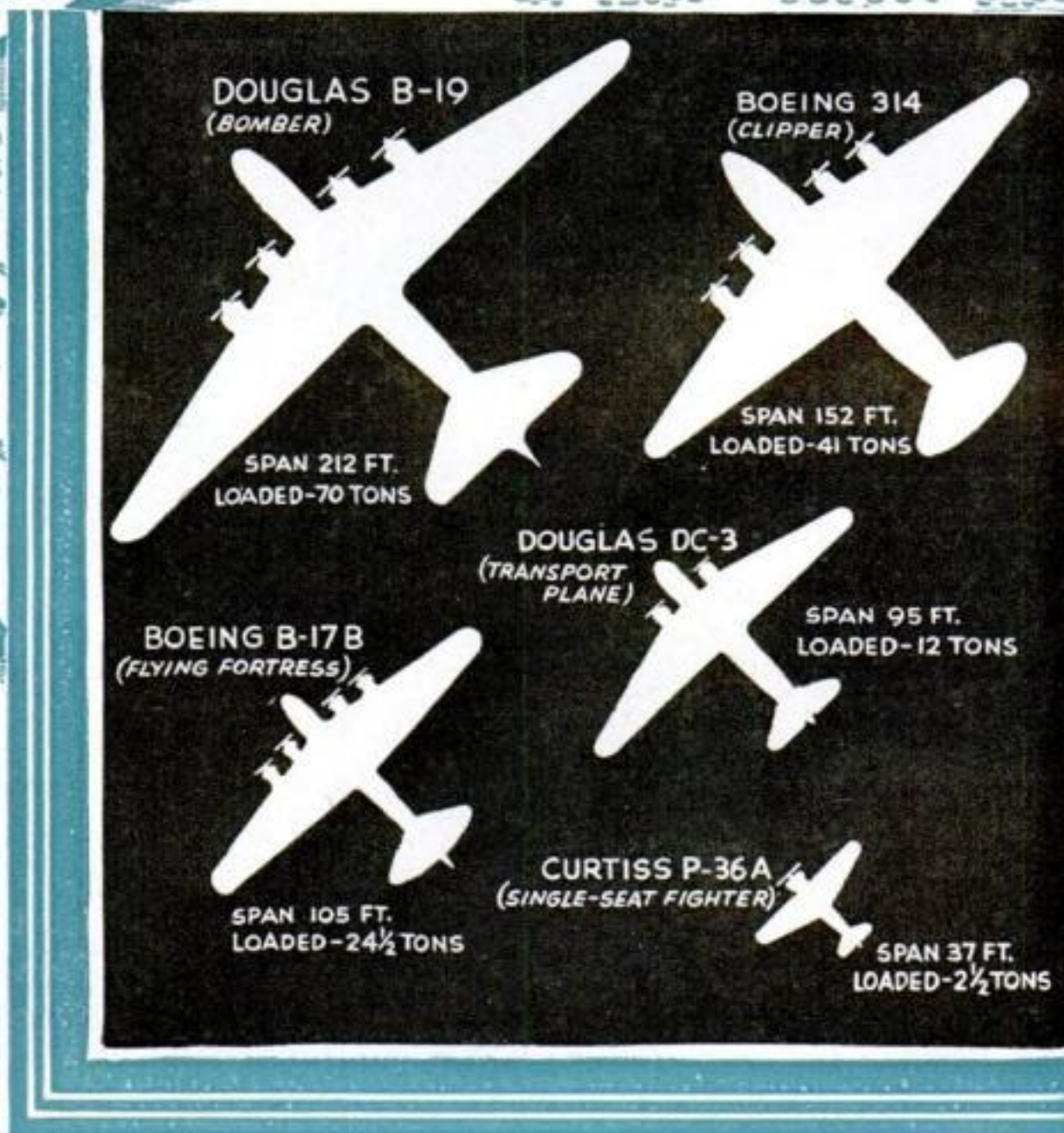
UNCLE SAM
BUILDS A

Europe-and-Back



By
**ANDREW R.
BOONE**

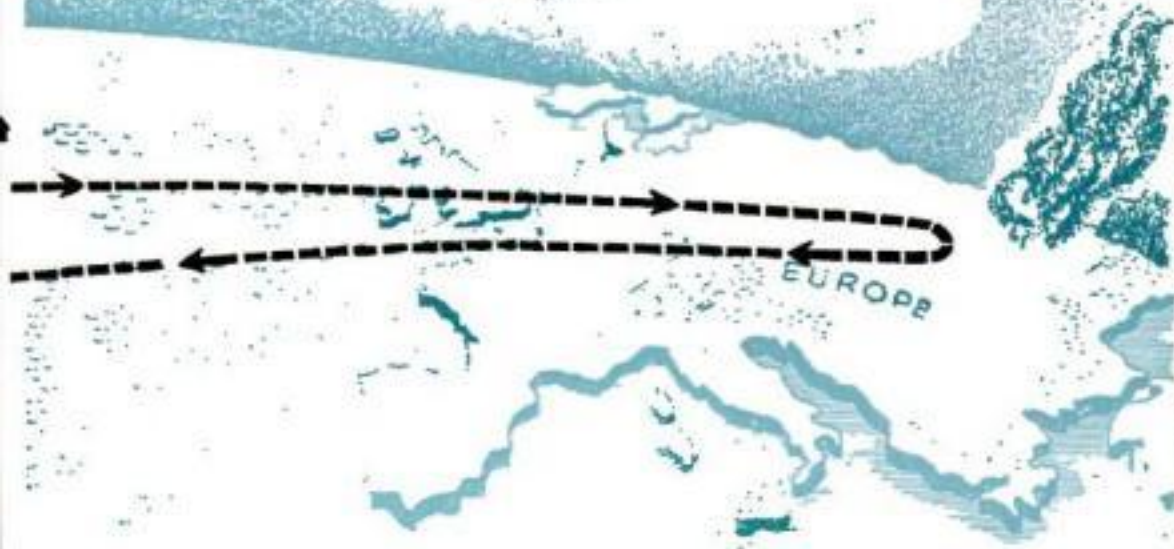
CAPABLE of carrying nine two-ton aerial bombs across the Atlantic, dumping them on an enemy objective, and returning to the United States without landing to refuel, the world's largest airplane soon will be launched from a flying field in southern California. Known as the U. S. Army Douglas B-19, the long-range bomber can climb with its eighteen-ton lethal load to an altitude of 22,000 feet and speed through the sky at 210 miles an hour. Its wing spreads 212 feet from tip to tip, and four 2,000-horsepower radial engines, turning sixteen-foot three-blade propellers, will give it more power than ever before has been supplied to



an airplane, either military or transport.

For four years, 500 engineers and mechanics have worked secretly at designing the big ship and constructing its parts. Recently, working with clocklike precision from a carefully checked "script," they guided the gigantic structure from the maze of steel girders in which it was fabricated

Warplane



and gently turned the fuselage and wing from a vertical to a horizontal position. When the engines are installed and gasoline poured into the wings, a crew of ten will test-fly the new leviathan. It will have a total weight, fully loaded, of 140,000 pounds.

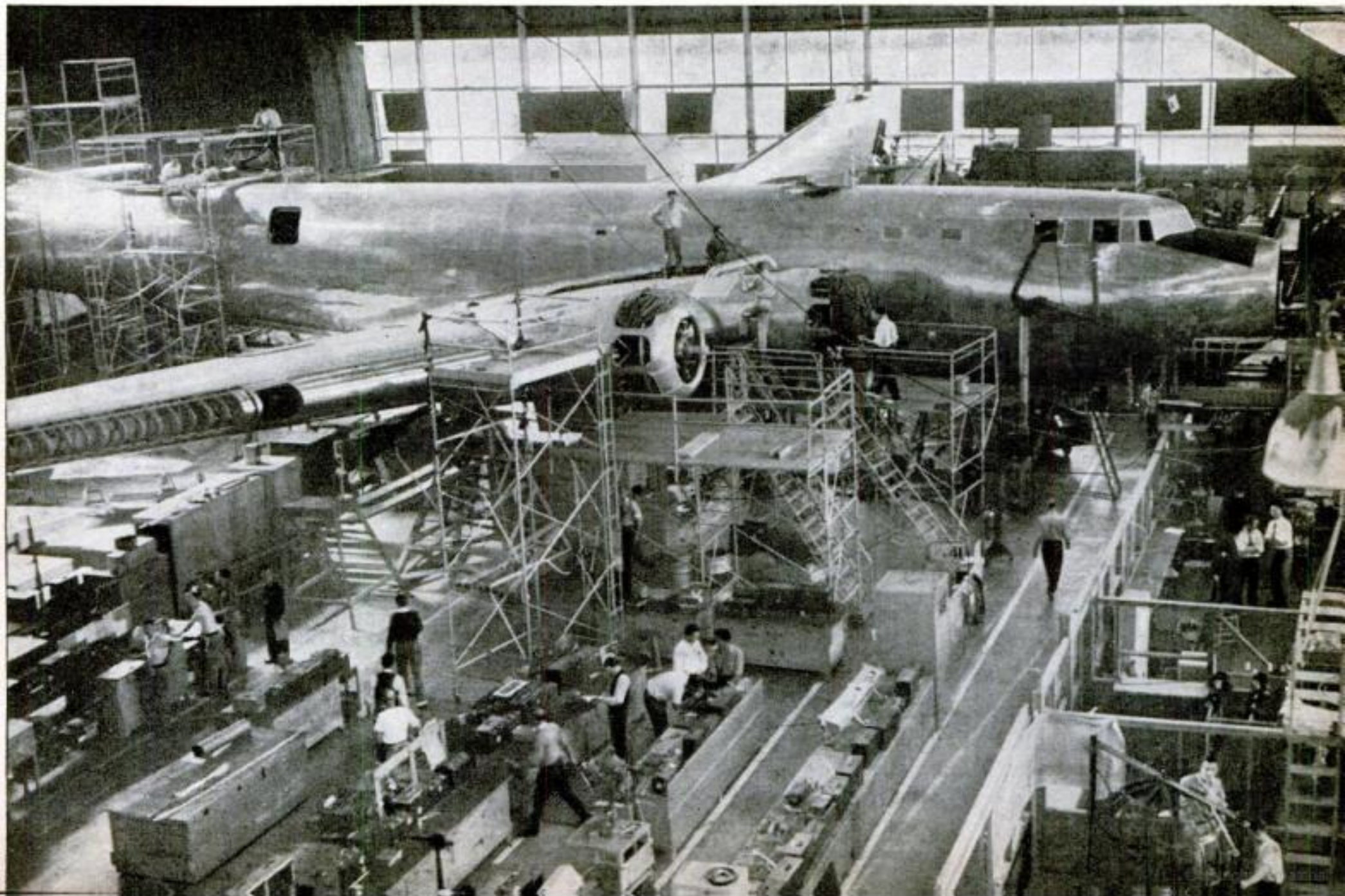
In building the new weapon of the sky, engineers concentrated on range and striking power, rather than on speed. Including a tricycle landing gear and a retractable nose wheel, the ship is constructed entirely of metal. Its wheels, eight feet in diameter,

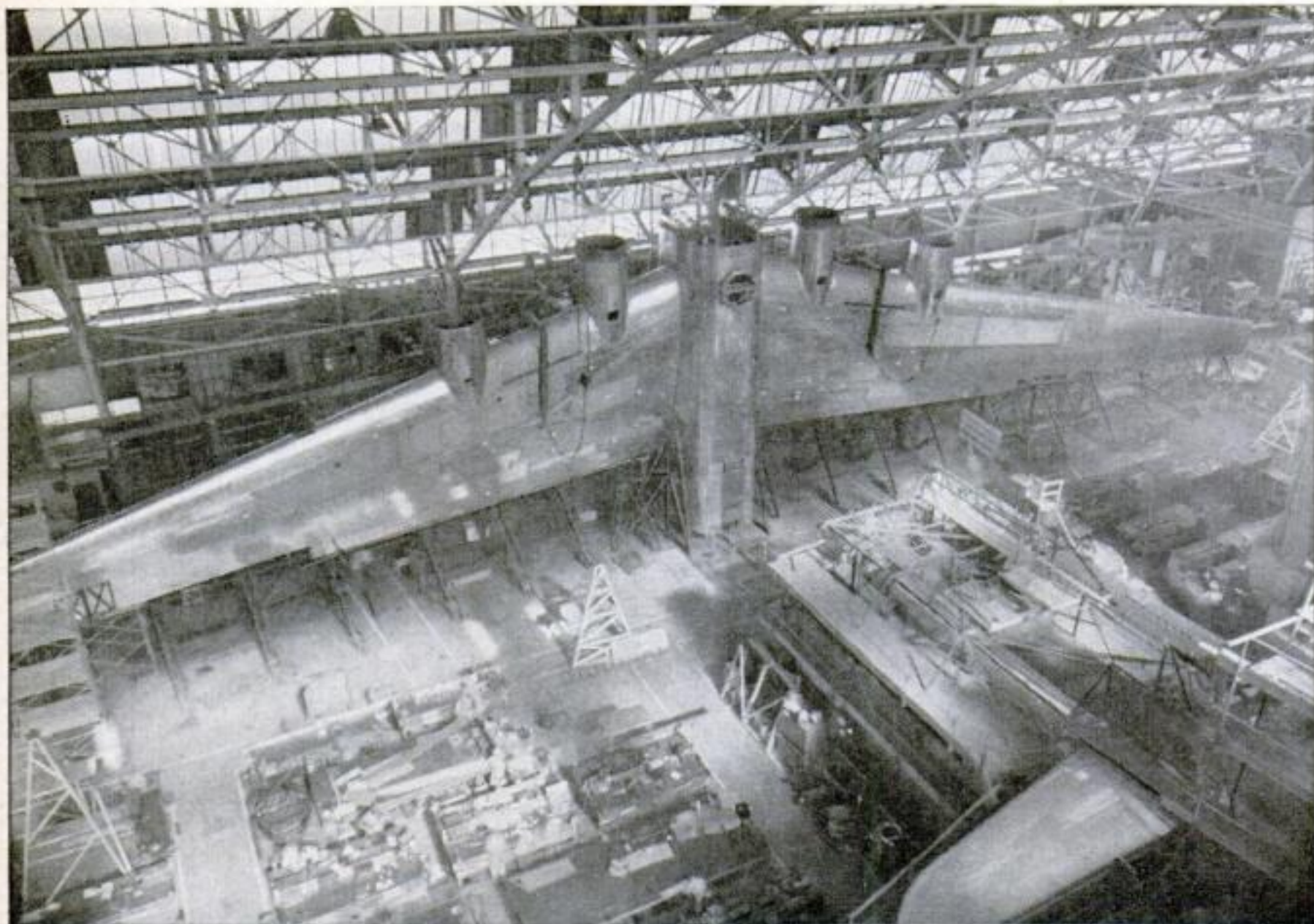


Assembling the leading edge of a 212-foot wing, held in a jig rising sixty feet from the floor

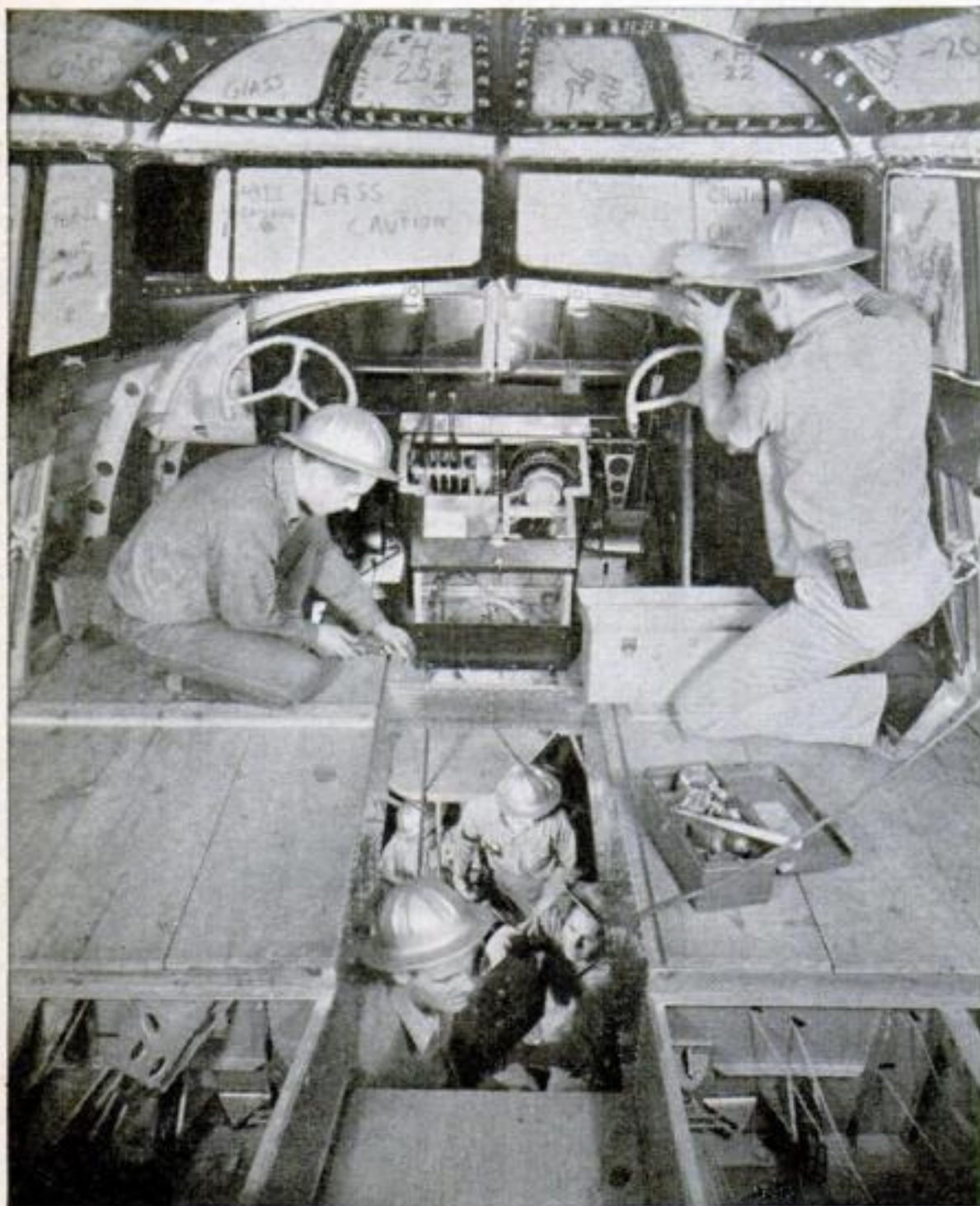
will disappear during flight in huge wells under the wing. The ship measures 135 feet from nose to tail, and the tail assembly stands as tall as a three-story building. Towering forty-two feet above the earth, the fin alone has an area larger than the

The U. S. Army's B-19, world's biggest airplane, takes shape in the huge Douglas factory in California





Fuselage and wings were fabricated in a vertical position amid a maze of girders. Below, mechanics at work in the roomy cockpit, connecting the many control cables



wings of the large twin-engine transports operating on the nation's air lines.

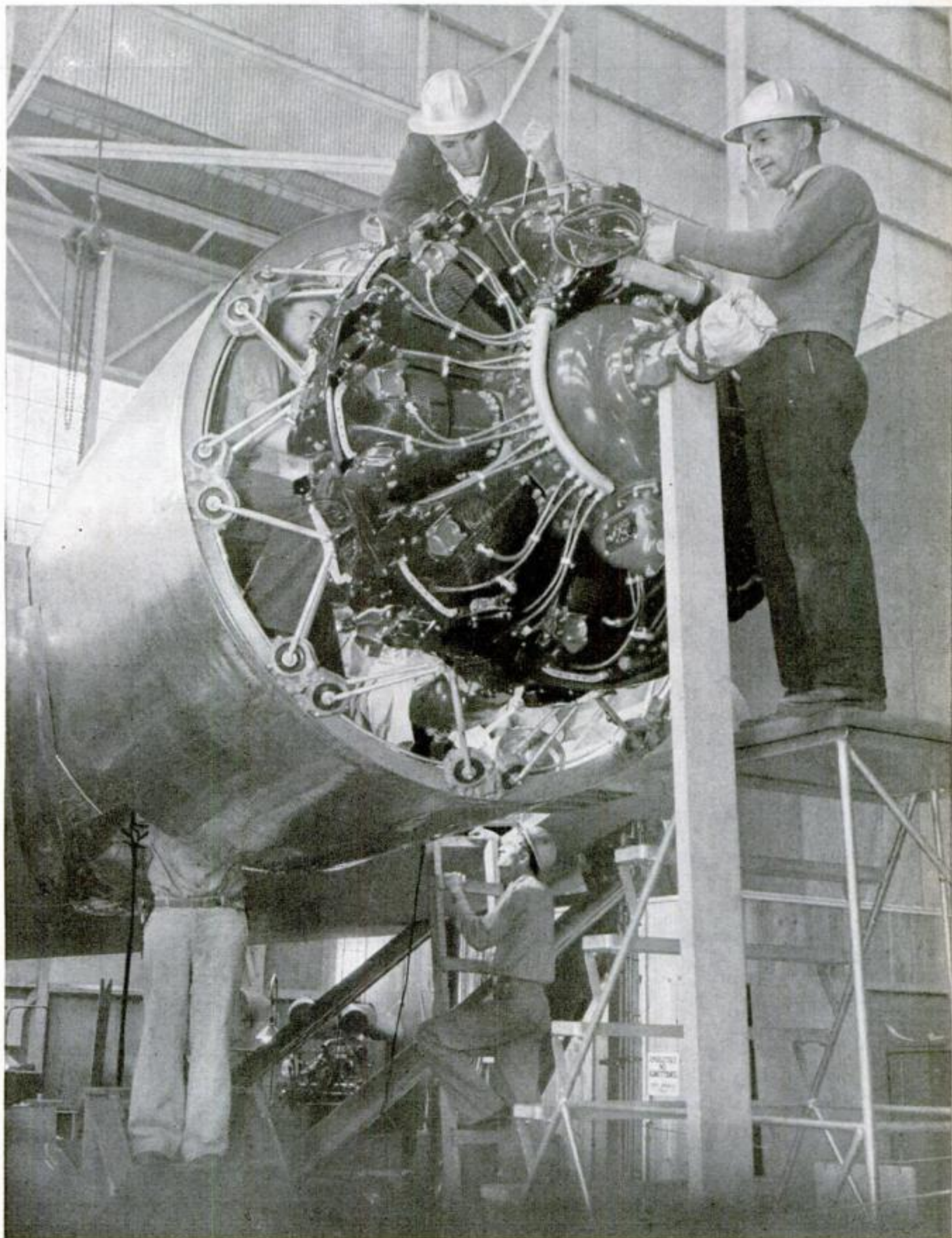
All the huge load of fuel required to drive the mammoth bomber on its long-range flights will be carried in the wings, in self-sealing cells that will prevent excessive loss of gasoline if the wing is punctured by bullets or shells. Baffles inside the fuel tanks keep the liquid from splashing about.

Under certain conditions of weather and load, the plane will have a range of 7,750 miles. Bristling with cannons and machine guns, it will be the most formidable fortress of the air ever designed. When taken over by the U. S. Air Corps in a few months, the B-19 will be used as a laboratory for

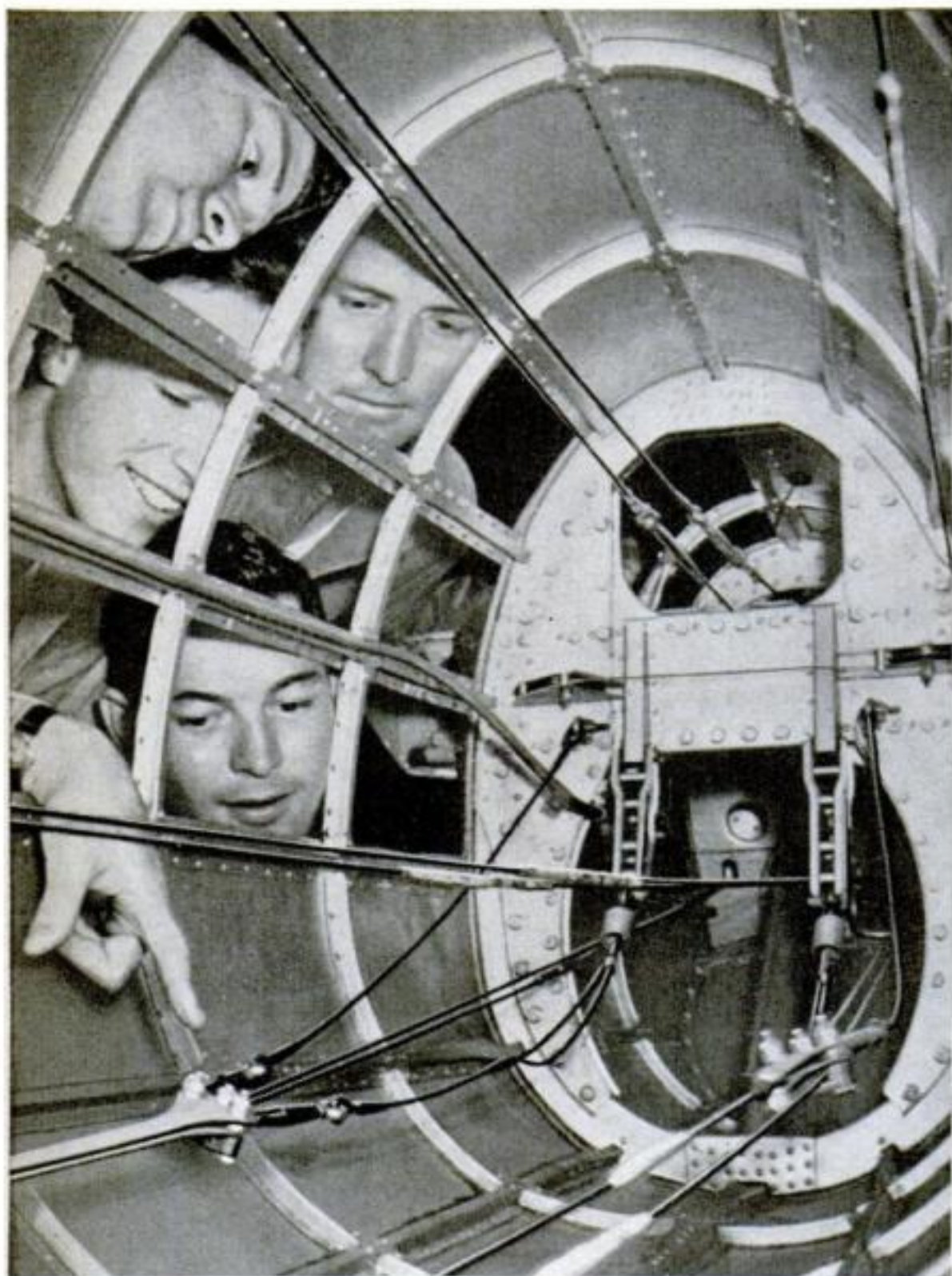
assembling and checking tactical and structural information from which may be developed large cargo and troop transports for the future.

Just as the Army's pioneering with the "Flying Fortress" paved the way for the development of the mammoth four-engined stratoliners, so the construction of the B-19

may blaze the trail for larger commercial sky liners. It may not be long before a plane like the B-19 will be carrying passengers across the Atlantic. Already, Pan American Airways is planning an ocean service with seventy-ton, 150-passenger ships. In the conquest of the air, wings of peace follow the wings of war.



One of the plane's four 2,000-horsepower engines being mounted in a dummy wing section for cooling tests



Army Flying Cadets See Plane Structure Through Open Panel

CUT away to reveal its interior mechanism, a fuselage of a big twin-motored plane helps train future Army flyers at Randolph Field, Texas. Through windows made by removing sections of the metal covering from the ribs, a clear view may be had of all the intricate control cables and wiring that go into a modern fighting craft. By first-hand study, under the direction of an experienced instructor, the flying cadets quickly familiarize themselves with the purpose, appearance, and mechanical design of each essential fitting which, out of sight during flight, nevertheless performs vital functions in control, operation, and performance of the giant aircraft. The illustration at left shows a group of them peering through the bared ribs to find out, with the aid of the windowed section, what makes a plane work.

Randolph Field flying cadets studying their subject at first hand

Mobile Air-Line Ticket Office Rides in Auto Trailer

SET up in an auto trailer and towed across country, a mobile air-line ticket office operated by Eastern Air Lines served travelers during the presidential campaign. Those who made special trips to Elwood, Ind., to hear Wendell L. Willkie's speech accepting

the Republican nomination, found the office parked at the scene as shown below. Stepping inside the door of the trailer where a completely equipped information department and ticket office were set up, they could obtain reservations for plane travel.



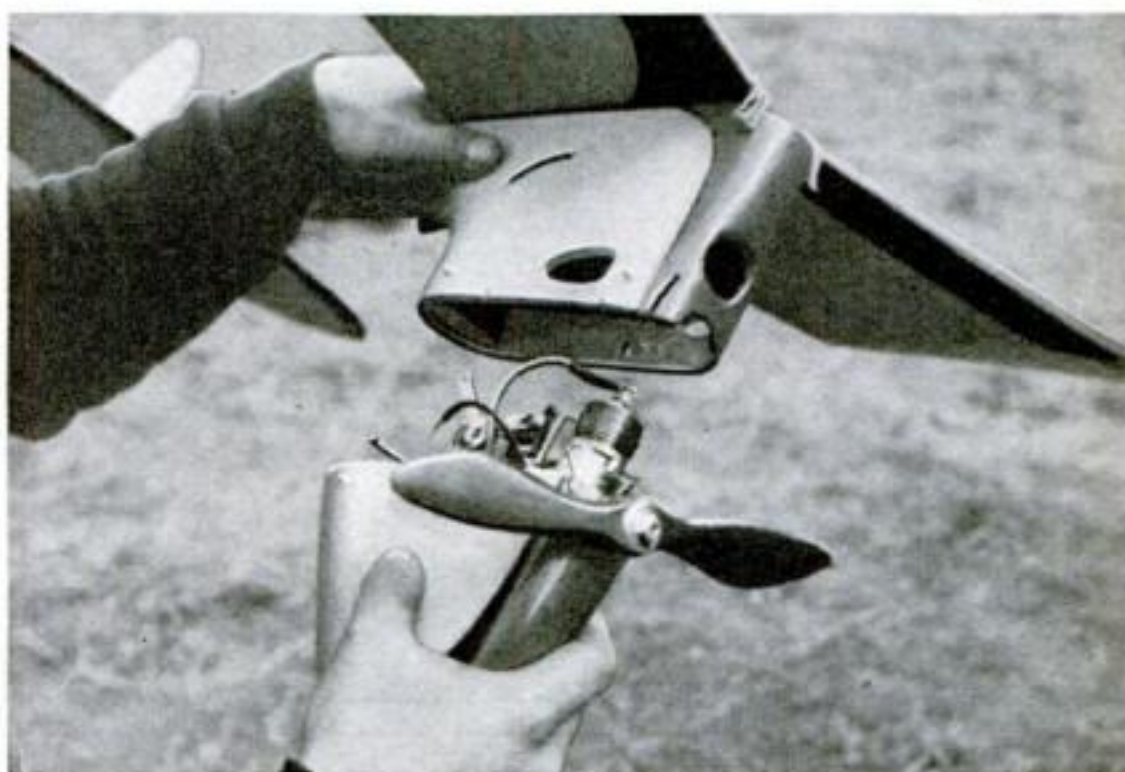
Eastern Air Lines's rolling ticket office. It can be towed anywhere to meet a rush of air travel

Spare Motor for Model Plane Is Installed in a Jiffy

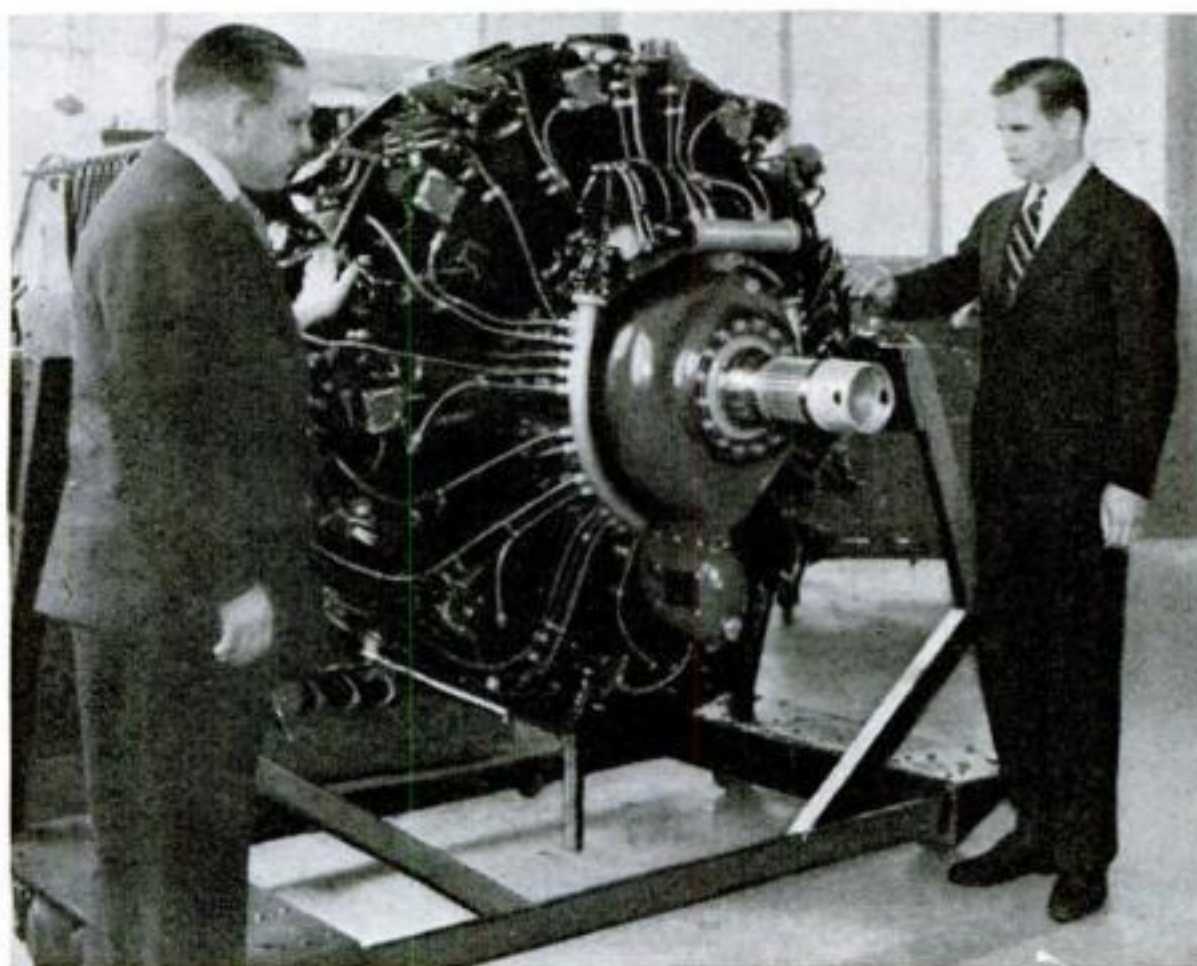
IF THE motor of his model plane balks during a competition, Michael Beechman, New York fan, doesn't care. He simply detaches an under section, containing the tiny gasoline engine, and substitutes a "spare." Ingenious design makes the power plants so readily interchangeable that only a few seconds' time is required. According to the young designer, the innovation does not interfere with the flying qualities of the plane, which lands upon a wheel at the bottom of the removable unit. Because of its shape, the builder calls it a "hatchet plane."

Airplanes May Get Hydraulic Drive

HYDRAULIC drive, recently introduced in automobiles, is applied to airplanes in an invention by Charles Adler, Jr., of Baltimore, Md. Pumps operated by the plane's engines force a fluid, such as glycerin or light oil, through pipes to turn turbinelike motors connected to the propeller. If one engine fails, all propellers can still be kept spinning.



Changing motors on Michael Beechman's gas-powered model plane is as easy as this. In the upper picture, the builder is seen with the model ready for flight. Note the landing wheel at the bottom



More power to our planes: the new eighteen-cylinder Wright engine

Air-Cooled Engine Hits New Mark of 2,000 Horsepower

CALLED the world's mightiest air-cooled motor for planes, the eighteen-cylinder giant at left marks a new advance in the quest for greater power. Four of these 2,000-horsepower Wright Cyclones will propel the enormous seventy-ton Douglas bomber under construction (page 56). Meanwhile, secret experiments are reported under way with a liquid-cooled, 4,000-horsepower motor of forty-two cylinders.

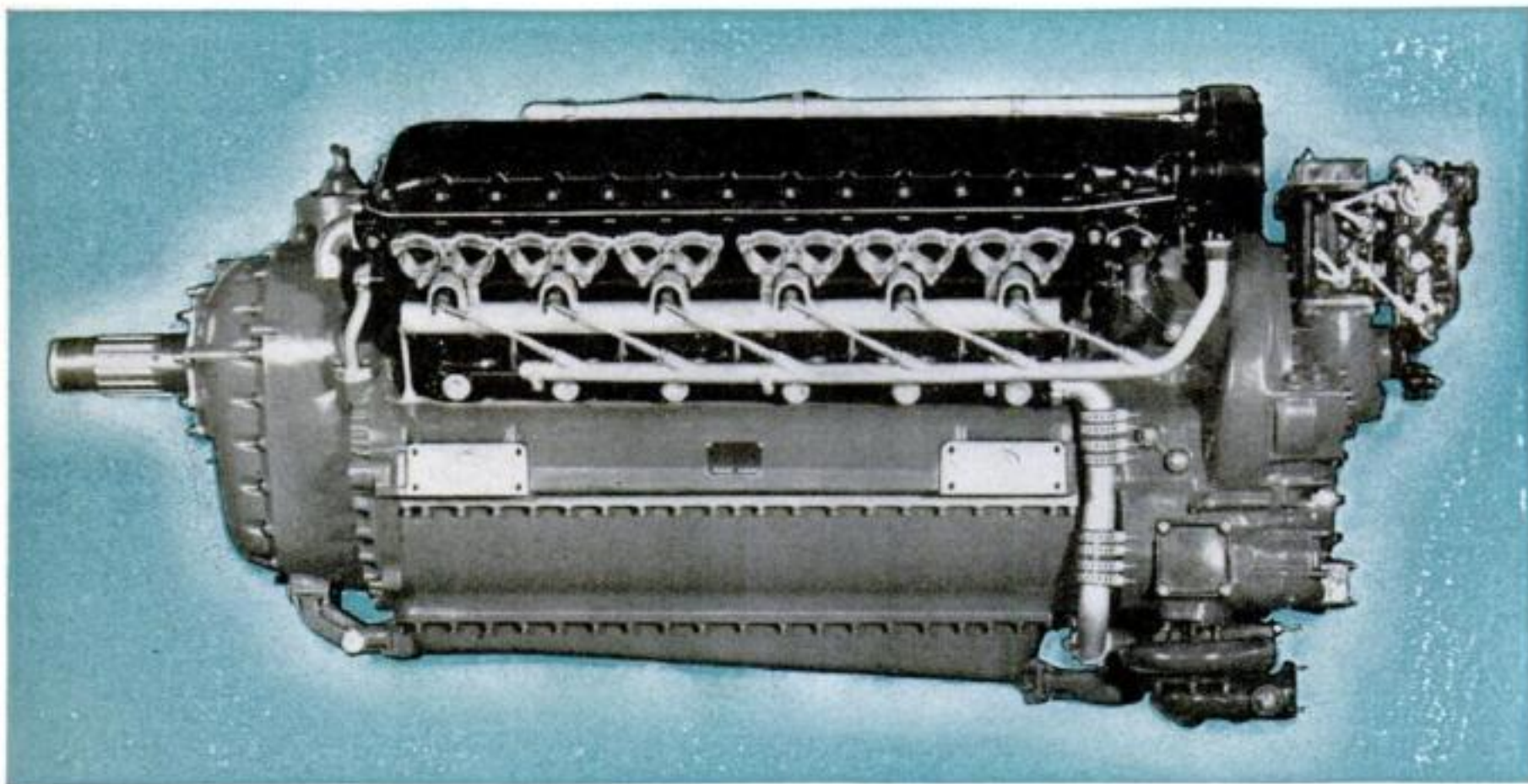
STREAMLINE MOTORS for Streamline Warplanes

CONDENSED FROM "FORTUNE," JULY 1940

HERE and there in the United States, like ganglia in a vast nervous system, factories are working at top speed in the production of power plants. The world is fighting a war of motors. The explosions in engine cylinders have become as important as the explosions in cannons and machine guns. The quick production of bigger and better engines for planes and tanks is a front-page problem of the day.

The more significant of these two engines of war is the motor used to power pursuit planes and bombers, the combatant and striking arms of the air force. Because of the great speed required in aerial tactics, motors for warplanes are now generally of 1,000 horsepower or more. In this country there are three manufacturers of such engines that are now on a production basis.

Two—Pratt and Whitney, and Wright—are established manufacturers of high-power radial motors. By December, each will be turning out 900 of these air-cooled power plants a month. The third is the Allison Division of General Motors at Indianapolis, which makes the Allison liquid-cooled motor, ranging from a twelve-cylinder job rated at 1,090 take-off horsepower, to a twenty-four-cylinder job, now in the experimental stage, tentatively rated at 2,300. The company sometimes ships as many as four or five engines a day, sometimes less. This winter when its present production plant will have been doubled, the management expects it will be turning out 100 engines a week, or 5,200 a year. The engine has already been accepted as the power plant for the Curtiss P-40 and the Bell P-39 (Airacobra), both single-engine pursuits;



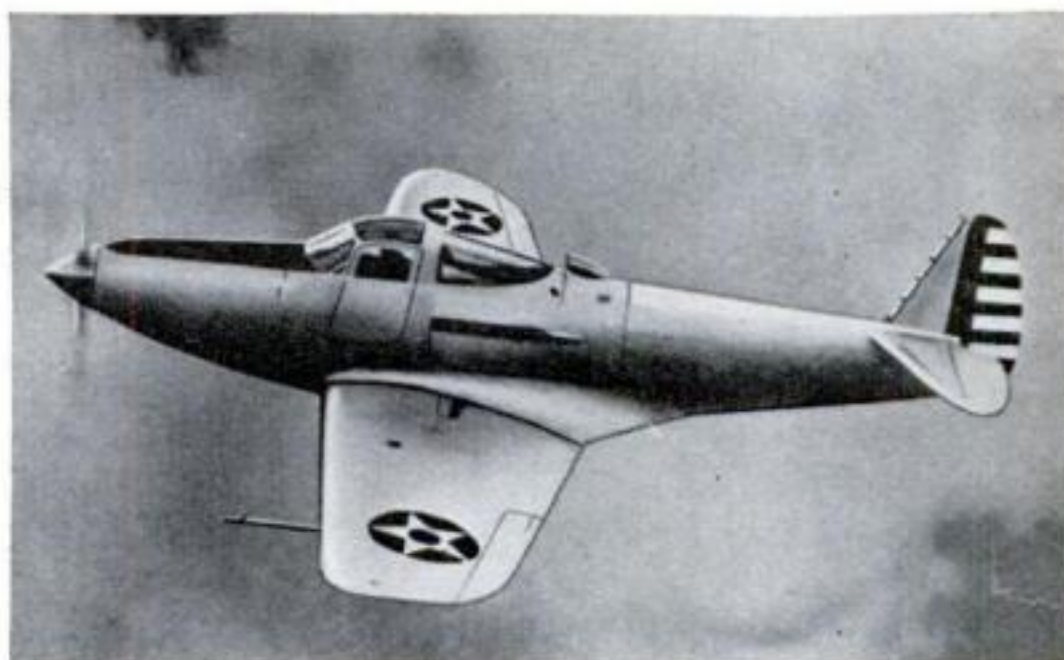
This is the Allison liquid-cooled airplane engine, accepted power plant for several leading types of fighting craft. It enables designers to build more speed and maneuverability into warplanes

the Bell FM-1 (Airacuda), a twin-engine multi-place fighter; the Bell XFL-1 (Airabonita), a Navy single-engine fighter; and the Lockheed P-38, a twin-engine interceptor. This acceptance was based on a model test, applied by the Government to motors made in the experimental shop. The Allison has yet to pass the production-type test, which is applied to the engine made in quantity in the factory.

If the production of Allison engines meets the managers' expectations, the country's annual rate of production of high-powered engines will be about 27,000. This will be enough to power 18,000 planes, for one engine should be held in reserve for every two in service. However, since many models will need either two or four engines, the number of planes will be about 12,000.

One of the reasons why the Government looks with hope at the Allison engine is that high-powered motors, up to now, have been put out by companies specializing in their manufacture; Allison, however, is an engine controlled and sponsored by General Motors, a fact that has caused the governmental and popular belief that the industry is now going to achieve mass production. This supposition has been based partly on the further fact that Allison, in a way, is a descendant of the Liberty engine of World War I, a mass-produced motor of 400 horsepower.

However, there is a great difference between the effort of 1917 and the effort of 1940. The Liberty engine failed as a military weapon abroad chiefly for the reason that the design engineers had too short a time to do the job. That they had the right idea was proved by the performance of the Liberty after the War. The Allison engine will also be mass produced, but under more favorable conditions. There has been sufficient development time, and orders for the engine have made it



In the Airacobra, the engine is behind the pilot's cockpit, allowing better balance and visibility for fighting



The Airacuda carries its two Allison motors in the rear of the gunners' compartments, giving the guns full play



The pencil shape of the Army's Curtiss P-40 pursuit ship is made possible by the use of the liquid-cooled engine



Assembling cylinder blocks in the plant of the Allison Division of General Motors at Indianapolis, Ind.

possible for General Motors to tool up. Indeed, the preparation has been so thorough that General Motors can actually build better engines by mass-production tools technique than can ever be built by hand. The finest handcraftsman cannot duplicate the accuracy of American machine tools. The problem is not so much in the application of the methods of mass production as it is in the adjustment of tools to operations upon materials that hitherto have not been subject to such machining. This is a matter of observation, adjustment, and practice in operation. Actually there are many tolerances in General Motors' gasoline automotive engines, and especially in its Diesel engines, that are as fine as those in the Allison. There are, however, more parts of the Allison engine that require micrometric attention to limits than there are in the other General Motors engines.

THE Liberty, which was also a V-type liquid-cooled engine, was rebuilt after the War in the very shops near the Indianapolis Speedway where Norman Gilman, an ingenious Yankee mechanic who had worked with Jim Allison on the old Liberties, planned the first Allison. Convinced that the engine of the future would be liquid cooled, he discarded water as a cooling agent and designed an engine especially for the use of a chemical cooler. This was in 1931, two years after the Allison plant had been

bought by General Motors. On April 23, 1937, the first Allison motor passed the 150-hour test and the long struggle to get it into mass production began.

The engineers who are bringing it into production give three major reasons for their belief that it may prove superior to the air-cooled radial types to which most of our productive capacity has been devoted. Their reasons are: first, the air resistance, or "drag," is less than in the radial; second, the Allison can be divorced from the usual position directly behind the propeller; third, it can maintain top speed for a longer time than the air-cooled motor.

The claim of less drag is based chiefly on the difference in frontal areas; the twelve-cylinder Allison has a frontal area of six and a quarter square feet as against an area of over sixteen square feet in the radial engine of the same horsepower. The lower area is a result of the V-shaped design, in which the cylinders are in line, arranged along a crankshaft, instead of protruding in the sunburst arrangement of the air-cooled radial. Drag increases as the square of the speed: if the speed is doubled, the air resistance becomes four times as great.

Distinctly more important is the fact that the Allison engine, being cooled by the flow of liquid around its cylinders instead of by a flow of air, need not be directly exposed to the air. It can be completely hidden in the wings or go back toward the tail. This

freedom of the engine position gives the designer a greater opportunity to design for maneuverability, which modern war technology and tactics may prove to be more important in combat than a few more miles an hour. The Airacobra is a case in point. Here the weights of the engine, the pilot, and the fuel are clustered around the ship's center of gravity. Here, again, fast handling of the ship is helped by the better combat and searching vision afforded by the pilot's position over the leading edge of the wing. Moreover, this plane requires a fuselage only thirty-four inches wide—less than six times the width of this page—to take the compact Allison.

The Allison engine can maintain top speed longer because it is easier to cool. Instead of water, which was used in the Liberty engine, the cooler is ethylene glycol, the same chemical used in nonevaporating automobile antifreeze solutions. Ethylene glycol is a by-product of the synthetic production of glycerin. Its boiling point is 387 degrees, compared with the 212 degrees of water. The pump forces it through the engine so swiftly that the heat dissipation is uniform in all cylinders.

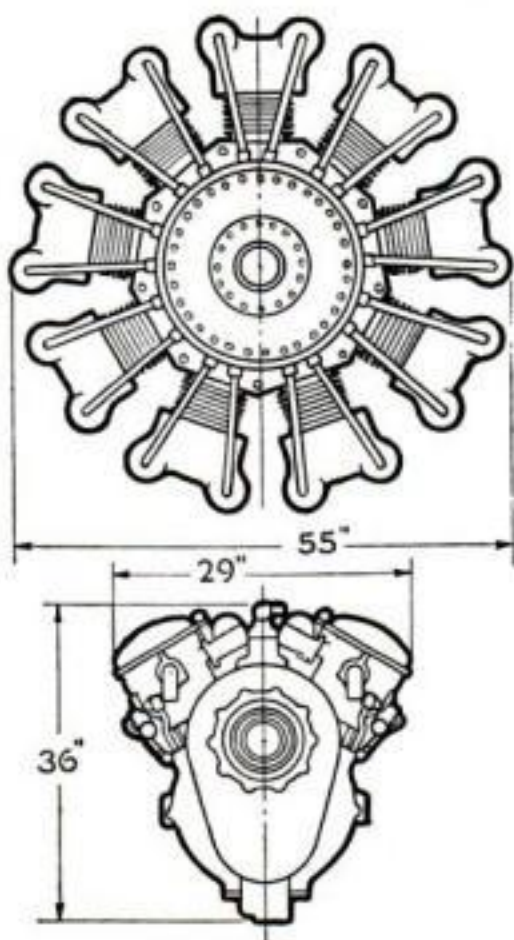
That's the Allison side of it. There are engineers, especially among the makers of air-cooled engines, who are not certain that Allison is all that its backers claim. Most of them accent the streamlining advantages, but they find them offset by the problems of installation. But this is

a technical debating ground, where time and research will settle the question.

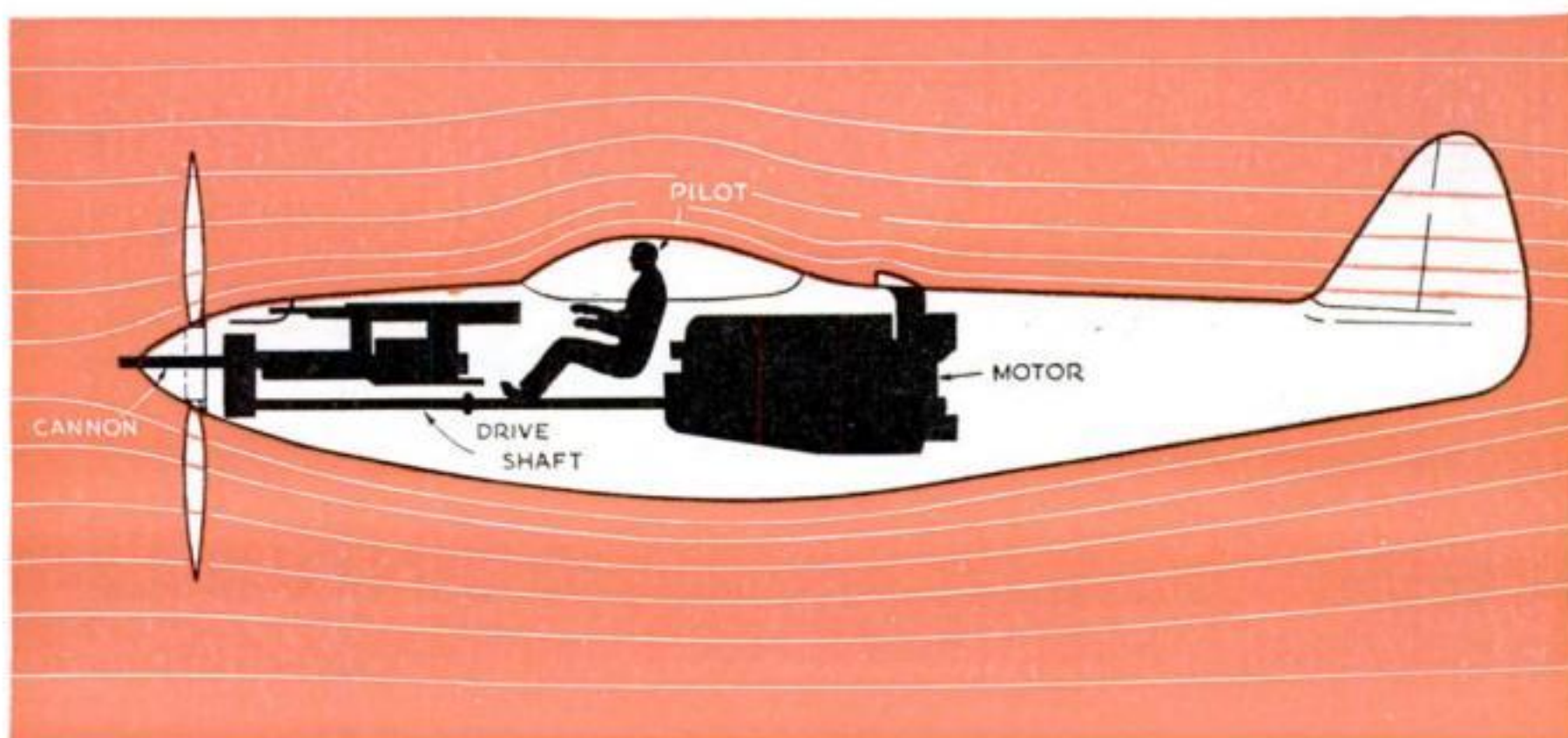
The name "Allison" is a remembrancer of Jim Allison, who, with Carl Fisher, founded the Prest-O-Lite Co. and later established the Indianapolis Speedway so that they could play with racing cars. Allison put up a machine shop to design and service the cars and gathered a staff of engineers and mechanics, whose superintendent, when the U. S. entered the World War, was Norman Gilman, an old-fashioned Yankee mechanic. When the war ended and surplus Liberty en-

gines were being overhauled, Allison obtained a contract to do some of the work. It was then that Gilman invented the famous Allison bearing—bronze integrated with steel—which solved the problem of getting more horsepower out of the Liberties. When Allison died and General Motors bought the plant (1929) to secure for development the bearings and a Diesel engine, then being designed, Gilman was made president and general manager of the new division. He built gears and propeller drives for the Navy dirigibles and many special engines; and began his study of the liquid-cooled type through work on the German engines on the *Los Angeles*, our trophy of the World War. The air-cooled engine had attained about 400 horsepower,

but Gilman, like one or two other engineers, became firmly convinced that the liquid-cooled type of power plant was destined to be the airplane engine of the future.



COMPARISON OF FRONTAL AREAS OF RADIAL AND IN-LINE MOTORS



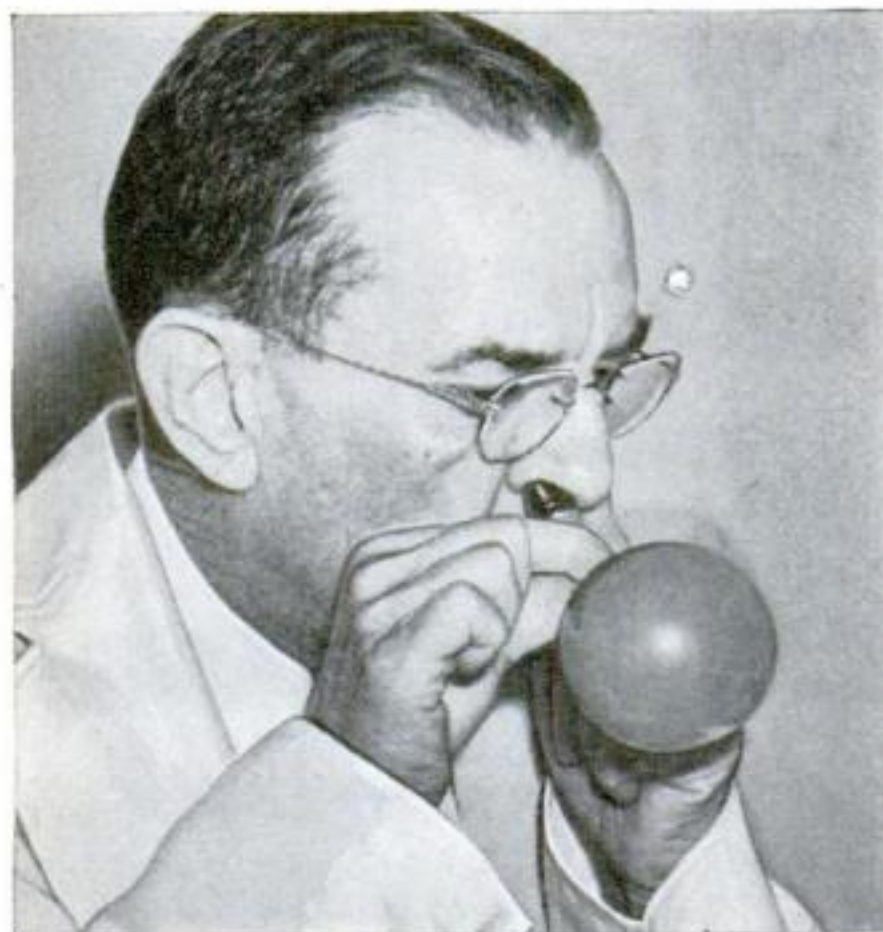
How a liquid-cooled motor, separated from the propeller, permits streamline design for higher speeds



Sound Guides Rocket Bomb Against Enemy Aircraft

GUIDED entirely by sound, a rocket bomb developed by J. R. Fish, a West Springfield, Mass., inventor, is designed to zoom straight for an enemy airplane at the almost incredible speed of 900 miles an hour. According to

the inventor, the rocket incorporates magnetic controls actuated by acoustic apparatus, steering itself directly toward the sound of an airplane motor to explode with terrific force when it reaches its objective. Ordnance engineers of the U. S. Army are said to be interested in the rocket projectile, and to have arranged a secret test of it on an uninhabited island off the New England coast.



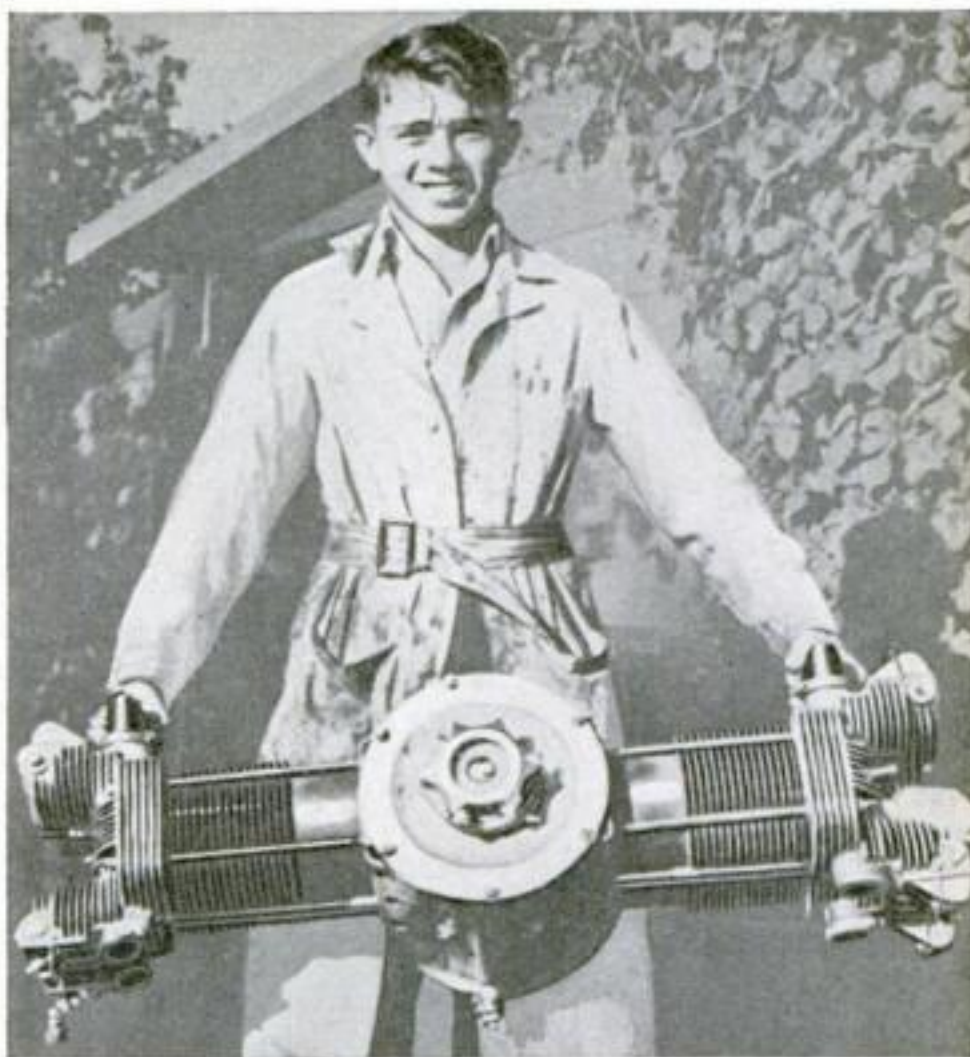
How the balloon is used to equalize air pressure

Balloon Ends Discomfort in High-Altitude Flying

TO MAKE things more comfortable for passengers and pilots flying at high altitudes, Dr. Ralph Greene, Miami, Fla., physician and medical consultant to Eastern Airlines, developed the balloon device pictured at the left. Costing only a few cents, the small balloon has a nipple fitted to its neck. When high-altitude pressure becomes annoying, the passenger inserts the nipple in one nostril, closes the other with his finger, and inflates the balloon. He then squeezes the balloon slightly and swallows. In this manner, the pressure of the air within the inner ear is equalized with the outside pressure.

Engine for Light Planes Weighs 130 Pounds

AN AIRPLANE motor that weighs considerably less than the two passengers who ride in the plane it powers—that is the accomplishment of Julius Dusevoir, inventor, of San Leandro, Calif. Actually tipping the scales at only 130 pounds, the lightweight motor is rated at seventy-five horsepower and will power a two-place light plane with ease. The engine, air-cooled and of double-opposed type, utilizes a built-up roller-bearing crankshaft, a development perfected some time ago by the same inventor. One other outstanding feature of the lightweight motor is the fact that it can be dismounted and dismantled with nothing more than two wrenches as tools. The lightness of the motor gives the plane in which it is installed increased pay load, or larger fuel capacity.



A man can easily lift this seventy-five-horsepower motor

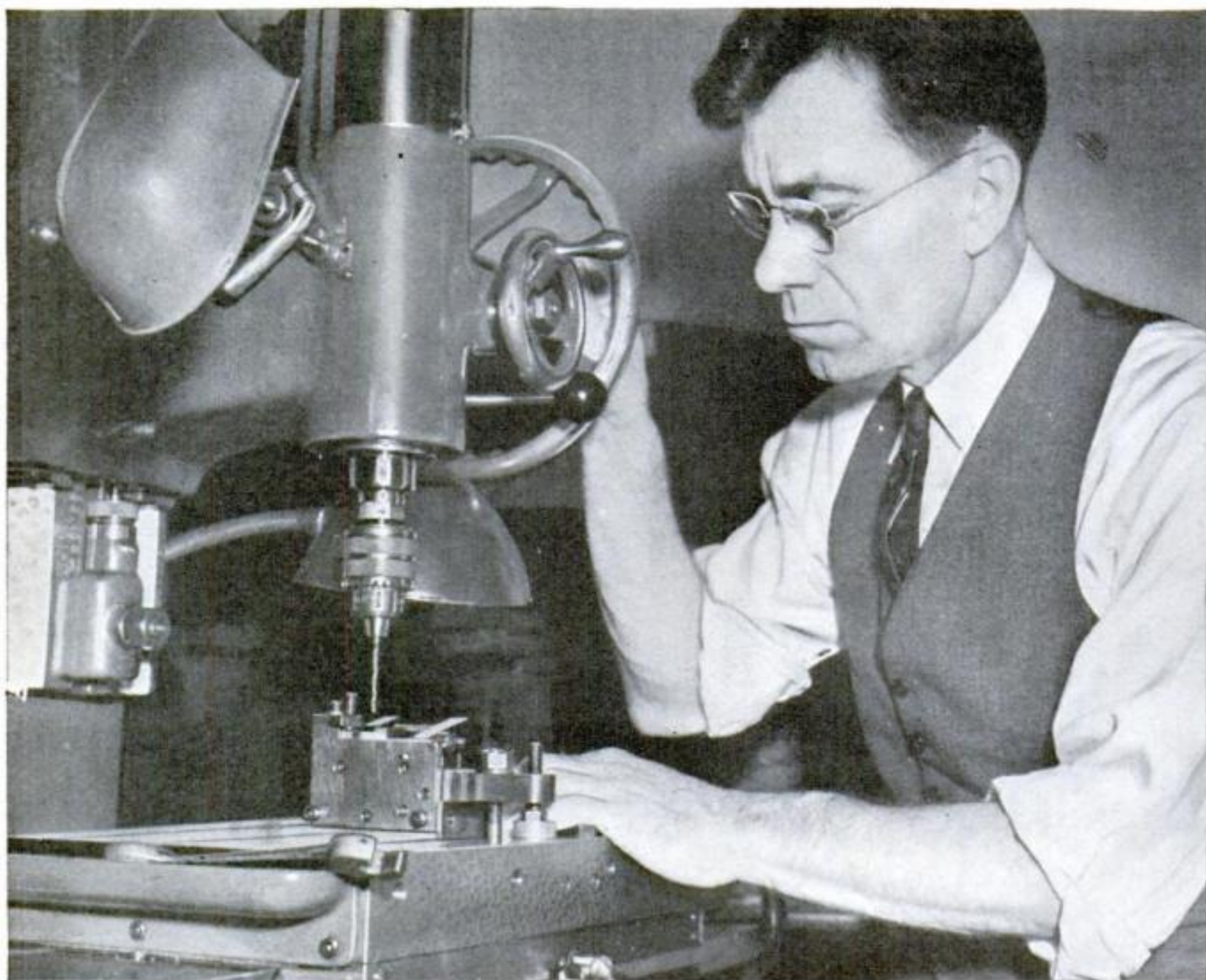
Signal Lamps Direct War Pilots in Patrol Formations

PICTURED in a recent action patrol along the Danish coast, the British airman shown below in an American-built Lockheed Hudson plane is making use of a special signaling lamp to give instructions through the

plane windows to other craft in the patrol formation. By this means, the leader of a squadron or group can signal units under his command without using his radio and thereby revealing his position.



Aimed through the window of a plane, the signal lamp blinks the leader's orders to accompanying craft



John C. Garand, creator of the U.S. Army's powerful new semiautomatic rifle, operating a drill press

HE INVENTED THE WORLD'S Deadliest Rifle

By EDWIN TEALE

THE United States Government is laying a \$15,000,000 bet that the new Garand semiautomatic rifle is the deadliest firearm ever invented. At the great, sprawling Springfield, Mass., Armory originally established by George Washington, Garand guns by the thousands are whizzing off the production lines, while outside, swarms of workmen rush through the construction of a vast addition to the plant.

Reams of publicity have carried the news of this rifle to practically every wide-awake U. S. citizen. But what about the man behind this particular gun? Who is this Garand, and what is he like? How did he happen to invent the weapon that will make every American doughboy a one-man machine-gun nest?

Alert, athletic, square-jawed—that was my first impression of John C. Garand when I walked into his Springfield Armory office a few weeks ago. As you talk to him, you notice that he pronounces certain words with a soft French-Canadian accent—a relic of his earliest years on the farm where he was born, twenty miles from Montreal. He was seventh in a family of fourteen chil-

dren. His mother died before he was eight years old and the family moved south to Jewett City, Conn. Here, at twelve, an age when most children are still in grade school, young Garand started work as a floor sweeper and bobbin boy in a New England textile mill.

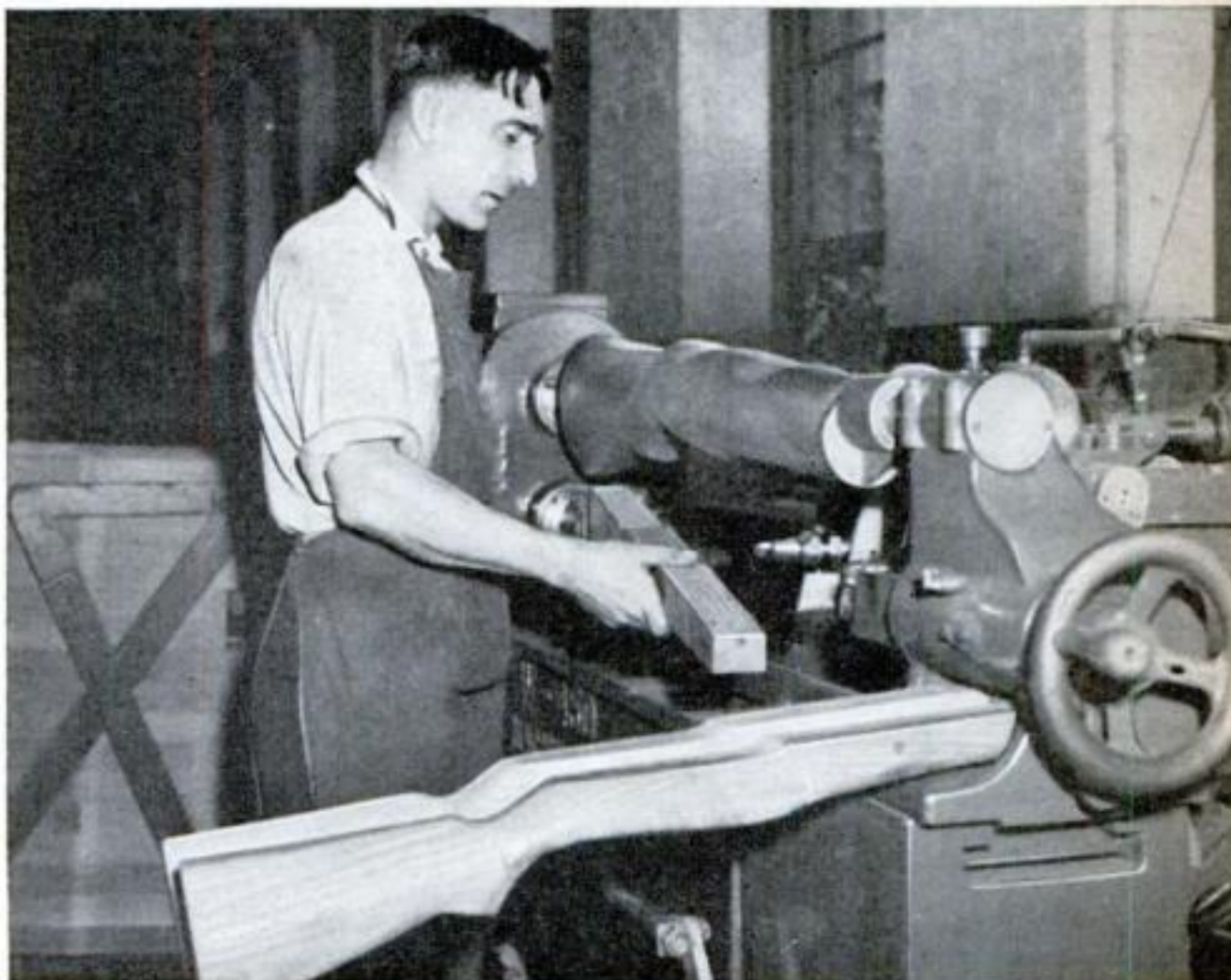
Machinery had always attracted him. Even today, Garand's idea of an exciting night's reading is to settle down in an armchair with a pile of machine-shop magazines beside him. During the short rest periods, while the bobbins were filling up, the boy used to haunt the end of the plant where the textile mechanisms were repaired. The foreman noticed him, took a liking to him, and let him pick up extra pennies scouring down rough places on spindles with a piece of building brick. A year after he came to the mill, Garand was a boy inventor with a patent of his own. He had designed a new type of jack screw.

As soon as he began making money, Garand started saving toward a rifle. With one of his brothers, he used to spend evening after evening poring over the gun pages of a mail-order catalogue, debating the merits of the different firearms. Finally, the boys pooled their resources and sent off a money order for a Winchester .32-20. When it arrived, with a blue, shiny barrel and smelling of fine oil, they discovered it had such a range that they couldn't shoot it without endangering cattle and farmers for miles around.

It was Garand's fertile brain that solved the difficulty. Obtaining a bent heavy metal pipe, the boys lugged it to a little hillock in the middle of a field. There they propped it up so that one end formed a bull's-eye and the other pointed skyward. At 200 yards, the boys drove their bullets into the open mouth of the pipe. The right-

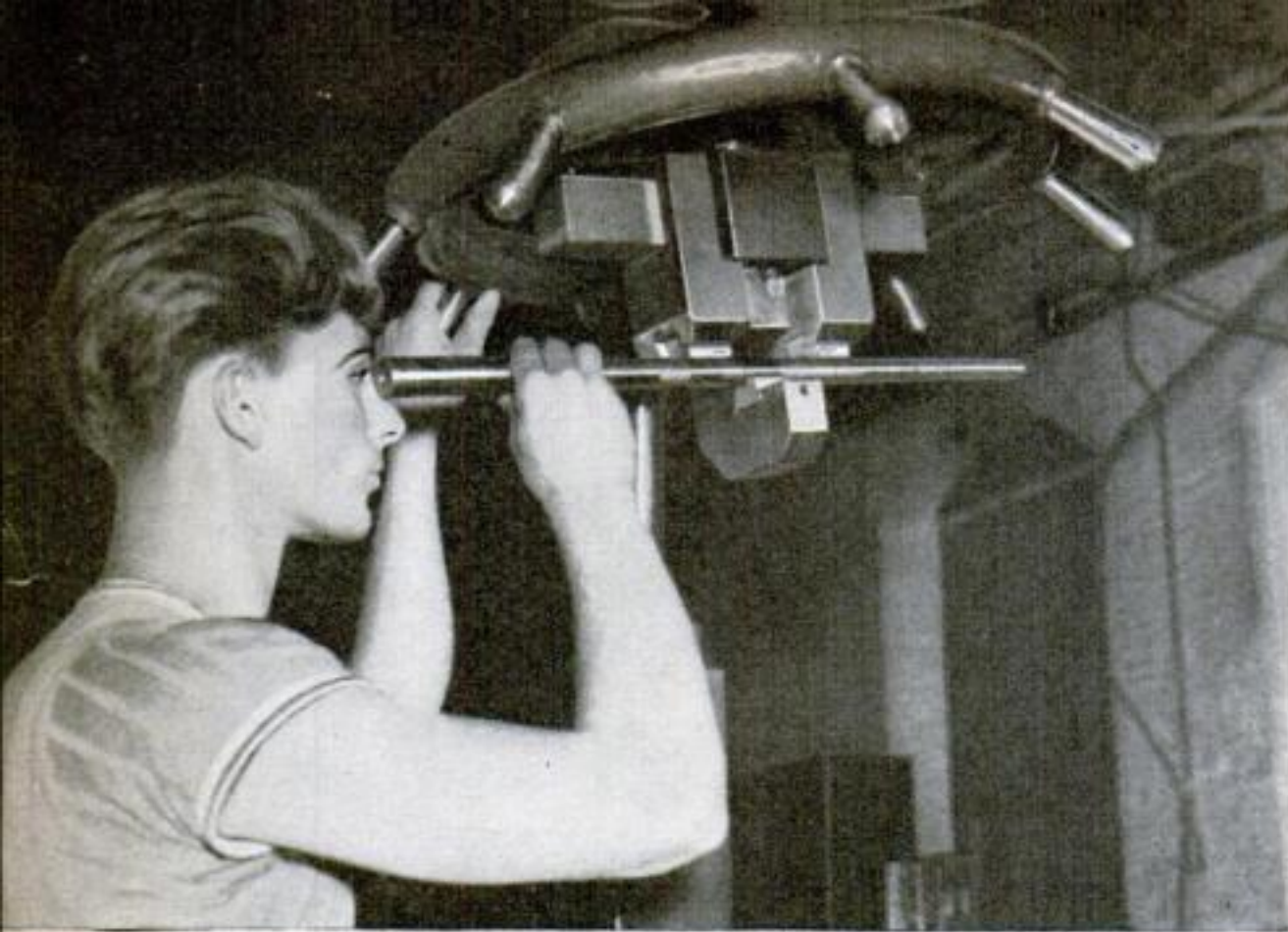


This is the barrel-rifling section of the Springfield, Mass., Armory, where Garand rifles are made for our doughboys. Big lathes tended by skilled craftsmen cut the spiral grooves inside the barrels



The flat-sided blank of Canadian black walnut in the hands of the workman above will become a glossy, brown rifle stock. Two round-ed pieces are seen in the machine. In the photograph below, racks of finished stocks are waiting to receive the barrels and mechanisms





Straightening a barrel. Under a trained eye, the machine applies pressure to correct slight imperfections. Springfield is turning out 500 Garands a day and expects soon to raise it to 1,000 a day



Guns for thirty more soldiers: a batch of completed rifles, inspected, tested, and tagged, moves off to play its part in Uncle Sam's big defense program. Below, Garand looks on as Col. G. H. Stewart, commanding officer at the Armory, examines the product



angle curve sent the lead streaking toward the stratosphere. However, its ear-splitting "zing!" resounded over the countryside and farmers, who were convinced a bullet had just missed their ears, came dashing up in buggies to register emphatic complaints. It usually took a long argument and a couple of demonstrations before they were satisfied.

By the time he was eighteen, Garand was a full-fledged machinist at the textile mill. As a side line, one summer, he and his brother ran a shooting gallery at Norwich, Conn. That was a lot like a boy with a sweet tooth managing a candy store. Their enthusiasm for target practice ate up most of the profits.

Not long afterwards, young Garand landed a job in a Rhode Island tool factory and moved to Providence. There the speed bug bit him and he took up motor-cycle racing. An engine of his own design carried him to victory at various New England tracks. Less dangerous, but still giving the thrill of speed and balance, was his next interest—fancy skating on ice. That occupied his leisure for several winters. He would still



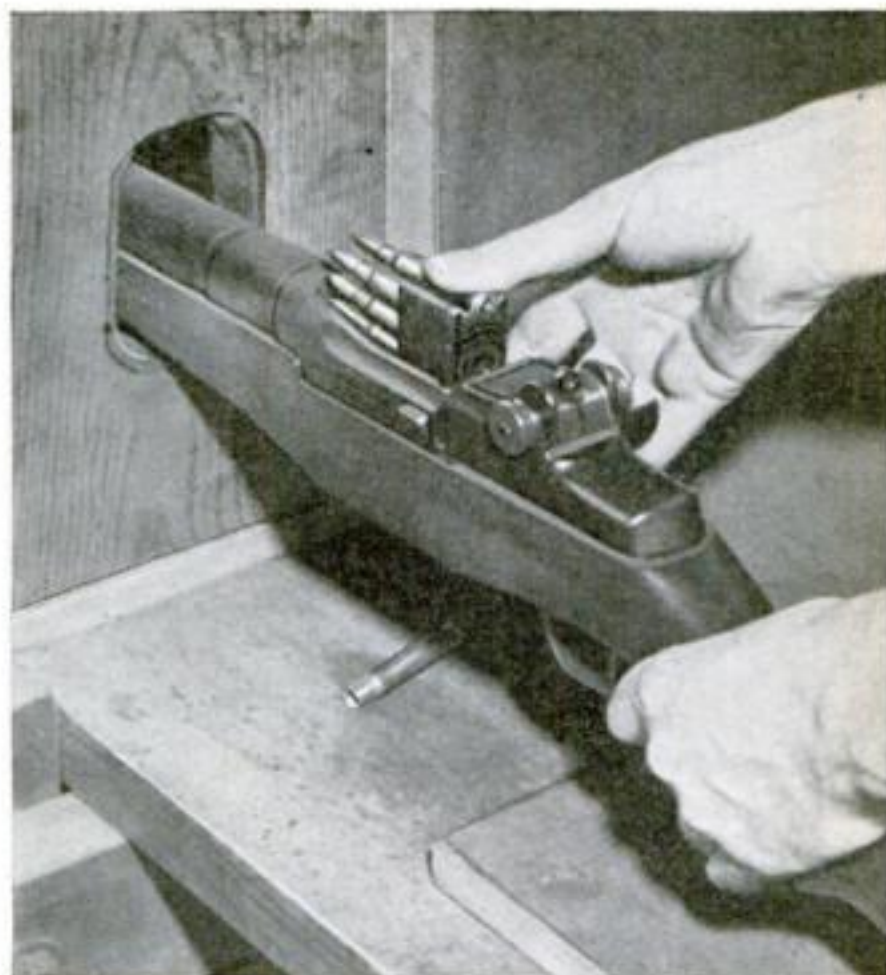
POPULAR SCIENCE

like to whirl and spin on skates, but he doesn't have time to practice. In spite of such varied hobbies, he always kept coming back to firearms. They formed the center of his interest.

In the early days of the World War, Garand came to New York, working in a micrometer plant in lower Manhattan. Saturdays invariably found him alighting from the subway at Coney Island with a target shooter's light in his eye. He was star patron of all the galleries along the boardwalk. Wages were good, and he shot to his heart's content. When he moved from one gallery to another, a queue of onlookers trailed behind. One Saturday, when he was finding out about rifles by using Coney Island as a laboratory, he shot at every target there. By nightfall, he had set an all-time high for himself, not only in score but in expense as well. He had spent \$100 at the galleries in a single day!

Luckily for his bank balance, he discovered a gallery near Times Square, about this time, where the proprietor would let him shoot free. Firing a rifle from the hip so accurately that he could hit a swinging target seven times on a single swing, he always attracted a crowd that overflowed onto the sidewalk and kept the cash register ringing at the gun counter.

During this period, when Garand was running the World War a close second in booming the stock of ammunition makers, he was taking correspondence courses, studying nights to complete a formal education that had stopped when he was twelve. One evening, before he sat down to his lessons, he read in a newspaper that the Government was having difficulty finding a satisfactory

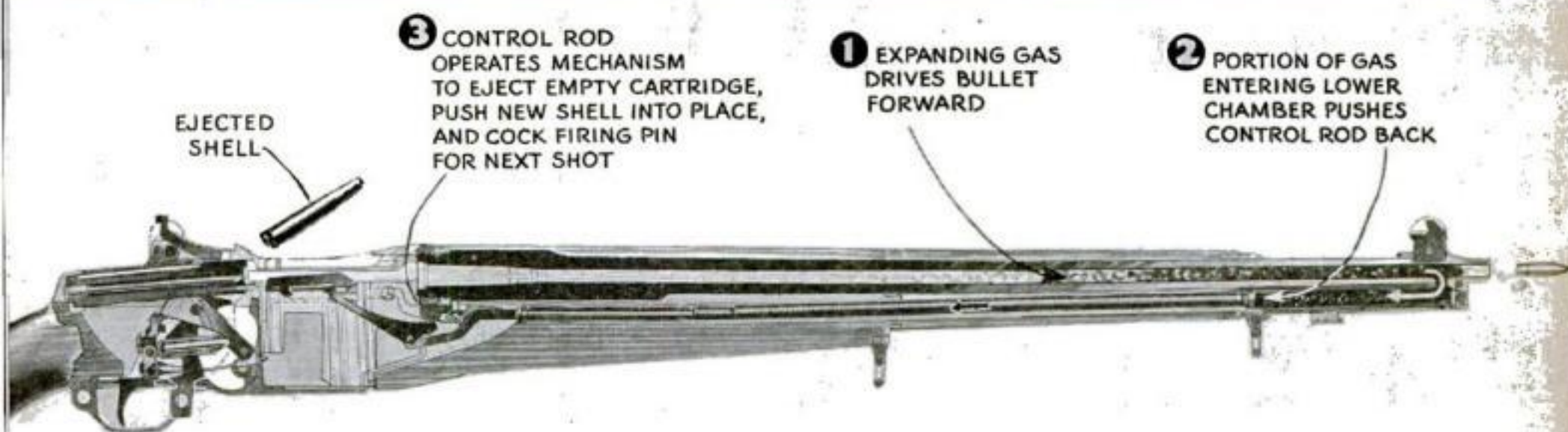


Before a new rifle leaves the Springfield Armory, it must pass this firing test in the proving room

machine gun. He couldn't see why there should be any problem about that, so he sat down and designed a machine gun of his own. Folding up his drawings, he slipped them in an envelope and addressed it to the Naval Board, in Washington, D. C.

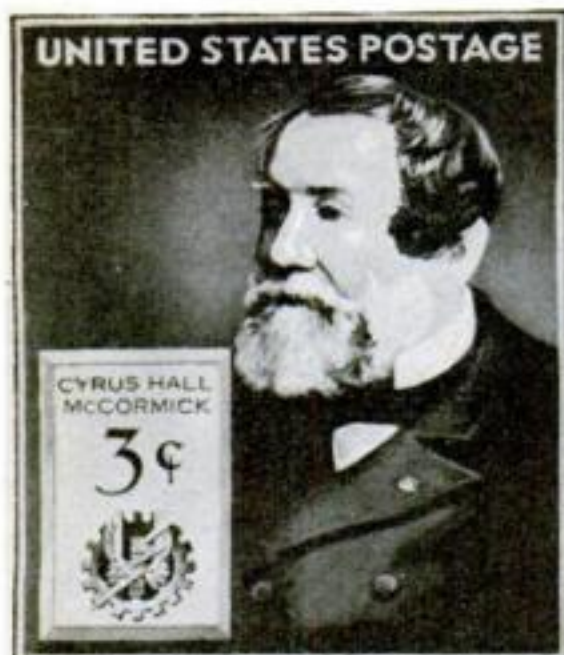
That act switched Garand onto the main track of his life work. It gave point and direction to his consuming interest in guns.

In due time, a letter came back from the Naval Board. The experts were sufficiently interested in his drawings to invite him to come to Washington for a conference. The upshot of that *(Continued on page 235)*

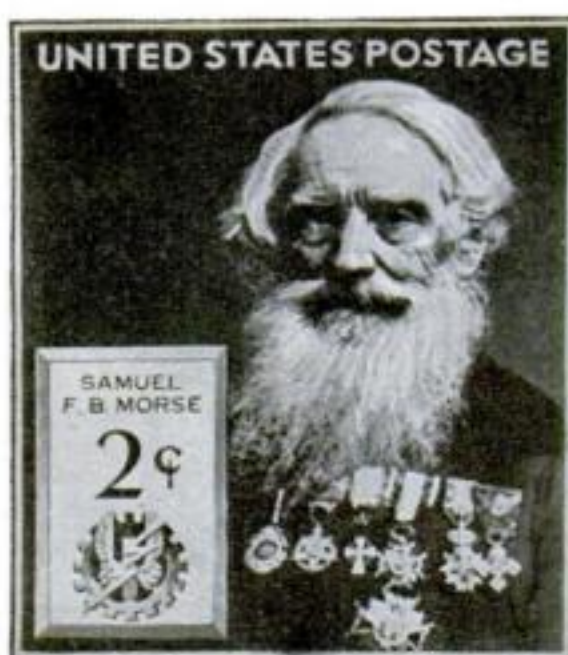


THIS drawing shows how the Garand semiautomatic rifle harnesses the "kick" to load the gun for the next shot. The pressure of expanding gas which drives the bullet from the barrel also operates the mechanism that ejects the empty shell and throws another cartridge into firing position. All the soldier has to do is to keep pulling the trigger.

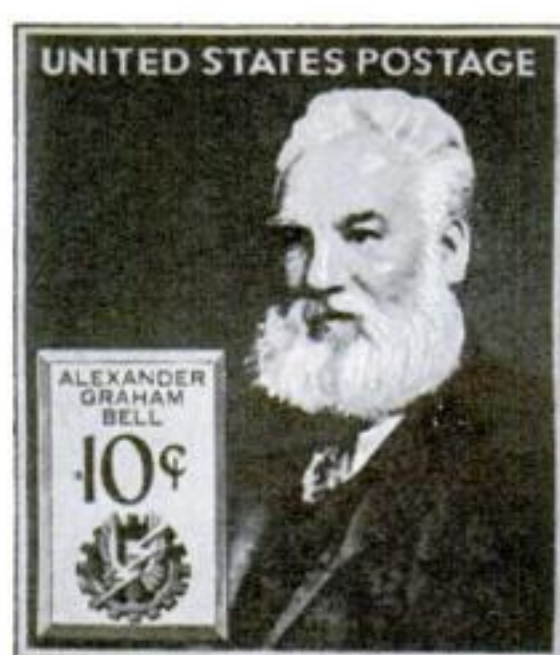
New U.S. Stamps Honor Great American Inventors



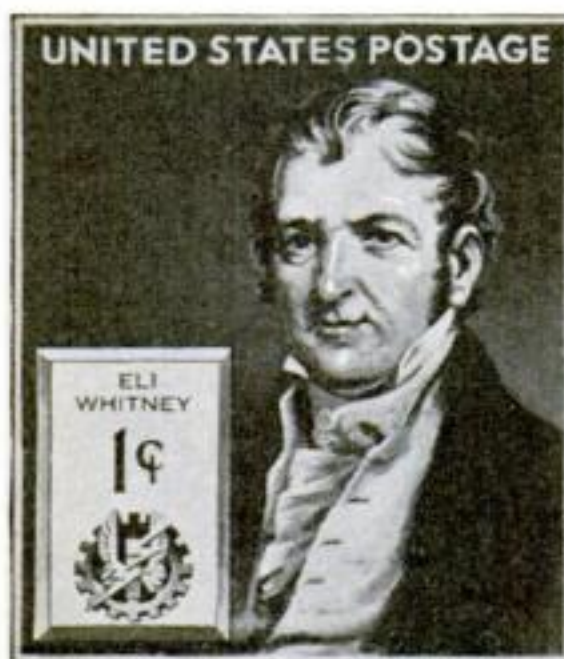
CYRUS H. McCORMICK, whose invention of the reaping machine helped pave the way for America's great agricultural development, was born in Walnut Grove, Va., in 1809. His first reaping machine was built in 1831 and patented in 1834. In 1847 McCormick went to Chicago and founded what is now the International Harvester Company. He died in 1884.



SAMUEL F. B. MORSE was a successful portrait painter before he invented the telegraph. Born in Charlestown, Mass., in 1791, he studied art after his graduation from Yale. The idea of the telegraph occurred to Morse on a voyage from Europe, and the invention was exhibited in New York in 1835. In 1844 the first public message was sent. Morse died in 1872.

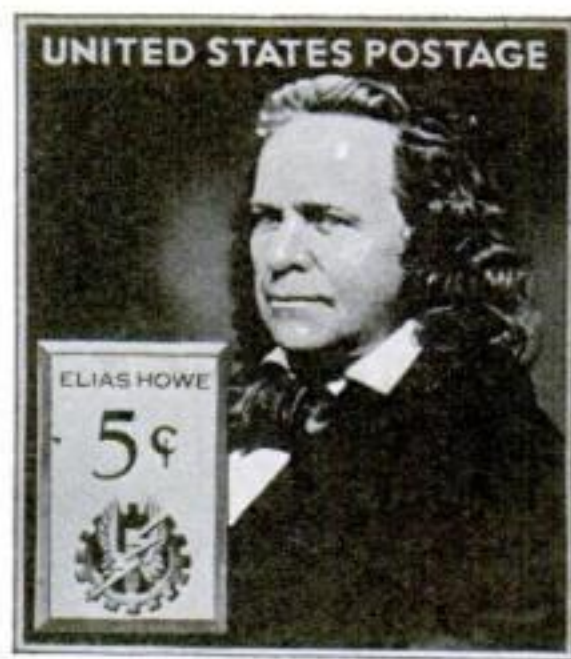


ALEXANDER GRAHAM BELL, father of the telephone, was born in Edinburgh, Scotland, in 1847. He came to Canada in 1870, and two years later became professor of vocal physiology at Boston University. His telephone was demonstrated at the Philadelphia Exhibition in 1876. Bell was greatly interested in the welfare of the deaf, and later in aviation. He died in 1922.



ELI WHITNEY revolutionized the South's cotton industry with the invention of the cotton gin. Born in Westboro, Mass., in 1765, he was studying law in Georgia when he was asked to develop a quicker way to separate the cotton fiber from the seeds. Using tools of his own making, he produced the ginning machine which was patented in 1794. Whitney died in 1825.

FIVE great American inventors are honored in commemorative stamps just issued by the U.S. Post Office Department in the Famous Americans Series. Each stamp bears an unframed portrait of the inventor, whose name appears on a panel in the lower left corner with the denomination and a device representing a cogwheel, uplifted wings, and a lightning flash — symbolizing power, flight, and electricity. Edison is not included, as a special stamp in his honor was issued recently.



ELIAS HOWE gave us the sewing machine. Howe was born in Spencer, Mass., in 1819. Although his lock-stitch sewing machine was patented in 1846, he had difficulty in getting his invention accepted and then in fighting infringements on his patent rights. After a long series of court battles he won out and made a large fortune. Howe died in 1867.



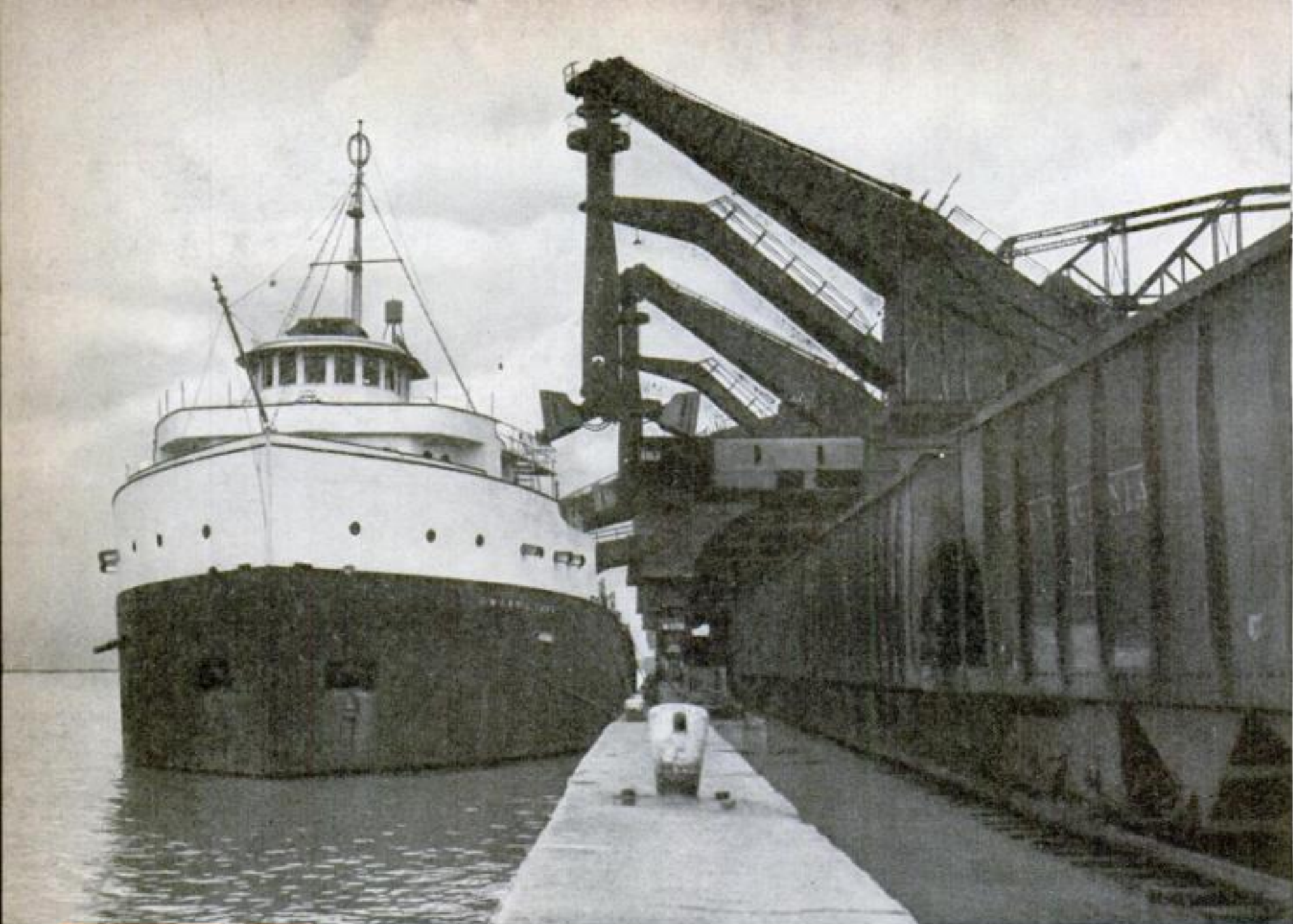
MOBILIZING MATERIALS

By ARTHUR GRAHAME

A TELEPHONE bell rang in the office of Edward R. Stettinius, Jr., chief of the National Defense Advisory Commission's materials division. It was the Chinese Embassy calling. A sizable quantity of tungsten had just become available in Indo-China. Would the United States be interested?

It most certainly would. Three calls by Stettinius brought quick results. The Reconstruction Finance Corporation would supply funds for the purchase. The Procurement Division of the Treasury would instruct one of its agents to do the buying. The





Mechanical unloaders biting into the 13,000-ton load of iron ore on a steamer at Cleveland, Ohio

Maritime Commission would arrange shipment. Next day, the tungsten was aboard an American ship, on its way to the U. S. A.

Why should high Government officials concern themselves about a load of tungsten, instead of leaving it to the regular channels of commerce? The answer is that U.S. mines yield less than a quarter of the tungsten that we need for armor-piercing bullets, lamp filaments, and tools. Therefore the Army and Navy class it among fourteen "strategic" materials vital for defense and currently obtained from abroad.

Other strategic materials include manganese, indispensable for purifying steel; rubber, for tires; chromium, for armor plate and high-speed cutting tools; tin for food cans, solder, and bearings; silk for parachutes and powder bags; coconut shells for the charcoal filters in gas masks. Mercury for fulminate detonators, antimony metal for storage-battery plates, manila fiber for ropes and cordage, mica for electrical insulation—all these, and more, have been checked as "musts" on Uncle Sam's shopping list.

If a war blockade caught us without them, America's mighty war machine might never get going. Trucks and gun carriages couldn't move, without bearings. Artillery shells without detonators to explode them would be no more potent than cannon balls. After tools available at the start of hostilities wore out, our prized Garand semiautomatic rifle would be impossible to manufacture. As Tom M. Girdler, prominent steel maker, puts it, "Down in Kentucky, in deep underground vaults, we have stored away a great pile of gold. The time might come when we would gladly give all of that gold for a pile of desperately needed manganese or chromium."

So we're taking no chances. A three-point Government program, now in full swing, is fast making the United States proof



HOW UNCLE SAM IS GATHERING THE MAKINGS FOR NEW GUNS, TANKS, SHELLS, AND PLANES



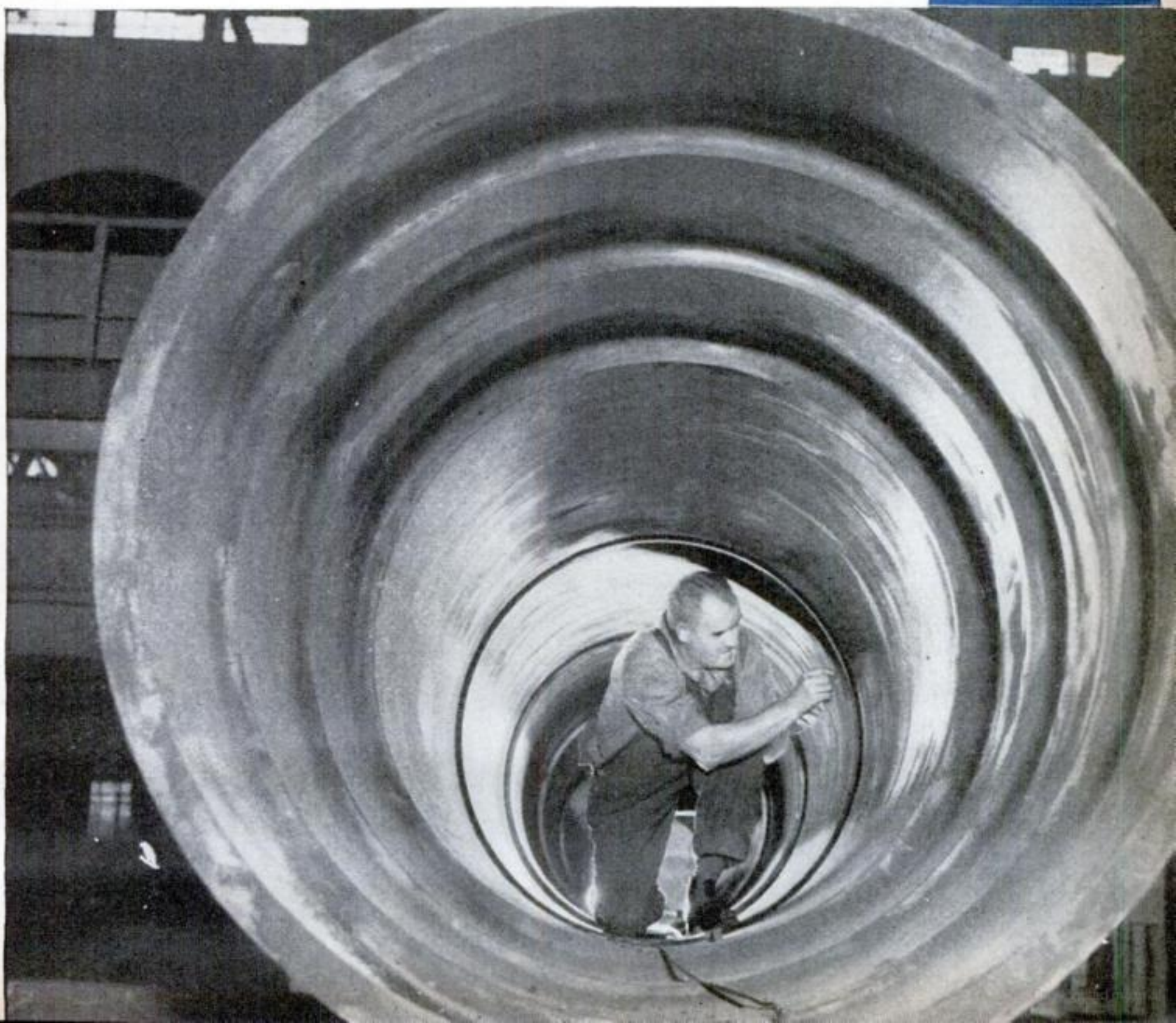
against blockade by any combination of hostile naval powers.

First comes the obviously sensible step of locating and exploiting key supplies nearer home. Dangerously vulnerable is the overseas trade route that brings us tin and rubber from British Malaya and the East Indies. So plans are well advanced to use Bolivian tin ore, by erecting smelters in the United States. Largely for lack of cheap fuel, Bolivia has no tin smelters, and has been sending the ore to England for refining. As for rubber, U. S. Department of Agriculture experts are making a \$500,000 survey in Brazil, locating favorable sites for establishing rubber plantations.

Widespread deposits of low-grade manganese in the United States and Cuba, long undeveloped, are now being honeycombed with mine shafts. Through a new electrolytic process, invented by Prof. Colin G. Fink of Columbia University, the ore can be purified to rival that of Russia and the African Gold Coast.

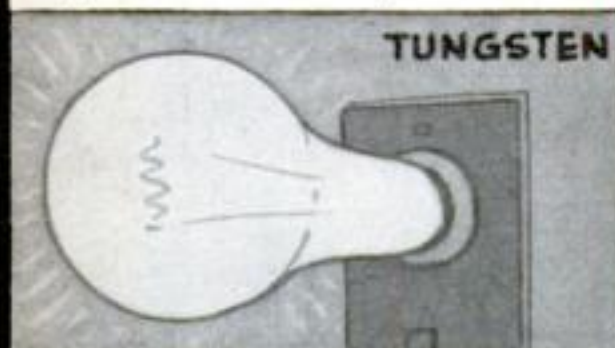
Soaring prices of Spanish and Italian mercury, to as much as \$200 for a seventy-five-pound flask, are reopening abandoned mines in California and Washington. National production from the

Inside the breech of a sixteen-inch gun barrel, a workman checks the finish





U. S. synthetic fibers, such as Nylon, could take place of silk



TUNGSTEN

Alternate source: U. S.; substitute: fluorescent-tube lighting



ANTIMONY

By developing our home sources, we could supply all our needs



COCONUT SHELLS

Alternate sources: Florida, West Indies. Substitute: treated wood



MANILA FIBER

Central American hemp, U. S. cotton, synthetic fibers replace it



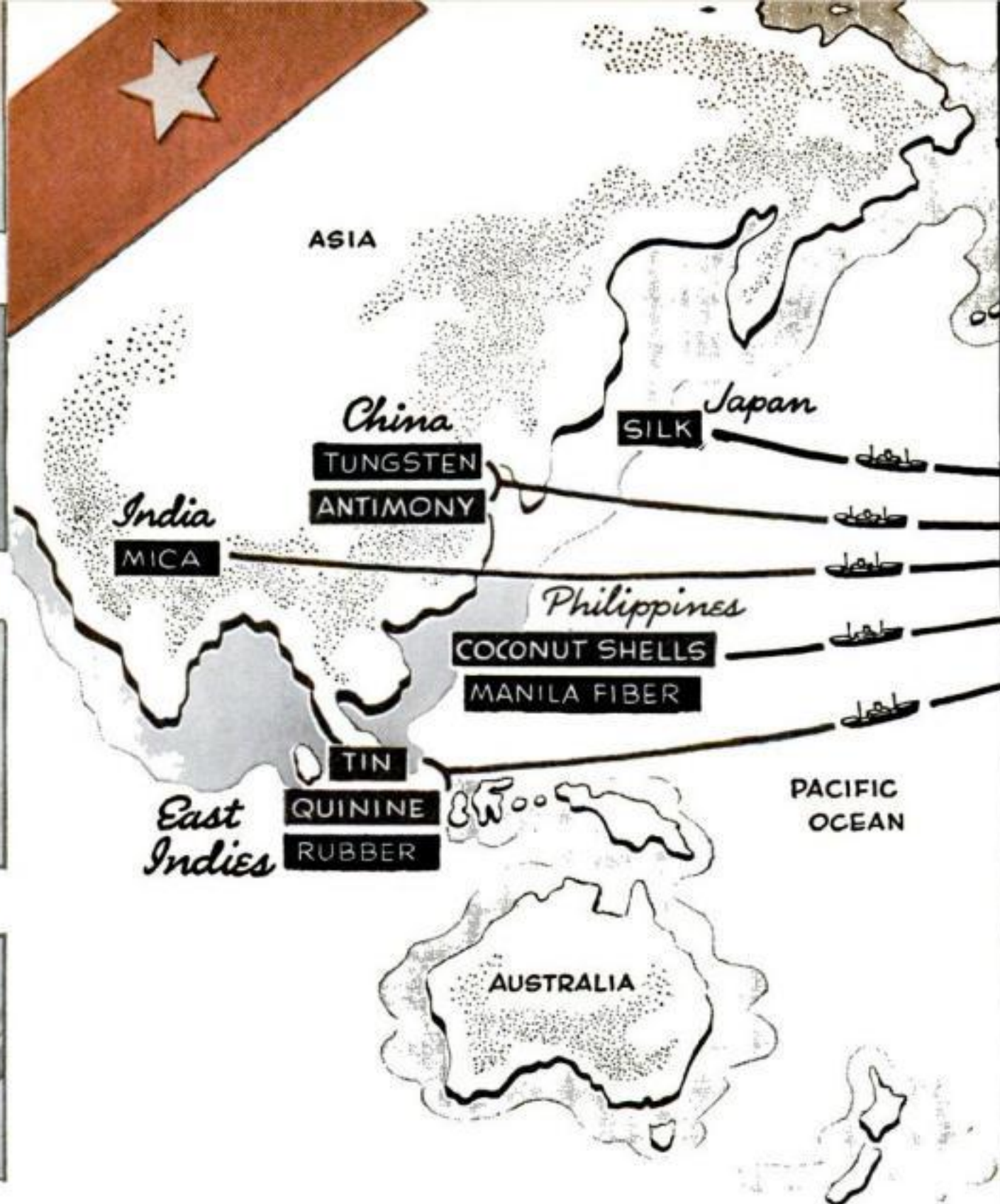
MICA

New sources: U. S., Canada, South America. Substitute: clay "paper"



TIN

Alternate source: Bolivia. Substitutes: other food packaging



scarlet ore, this year, may amount to 25,000 flasks. In time of peace, this is enough to fill all our needs. But what of extra wartime demands?

Here is where the second phase of our raw-material preparedness comes in—to find substitutes that can replace or supplement items on the strategic list. If Germany and other embattled countries can go "ersatz," so can we, and our chemists and metallurgists are prepared to go them one better. Surprises are in store for housewives and soldiers alike.

Eating soup and beans out of silver-lined cans appears a likely prospect. To make ordinary tin cans, a coating of tin is applied to "black plate," or flat rolled steel. In case of need, however, the steel could be plated first with copper and then with silver. Since the precious-metal coating need be no more than a millionth of an inch thick, it would cost only \$1.60 to line 1,000 quart-size cans with silver, according to Dr.



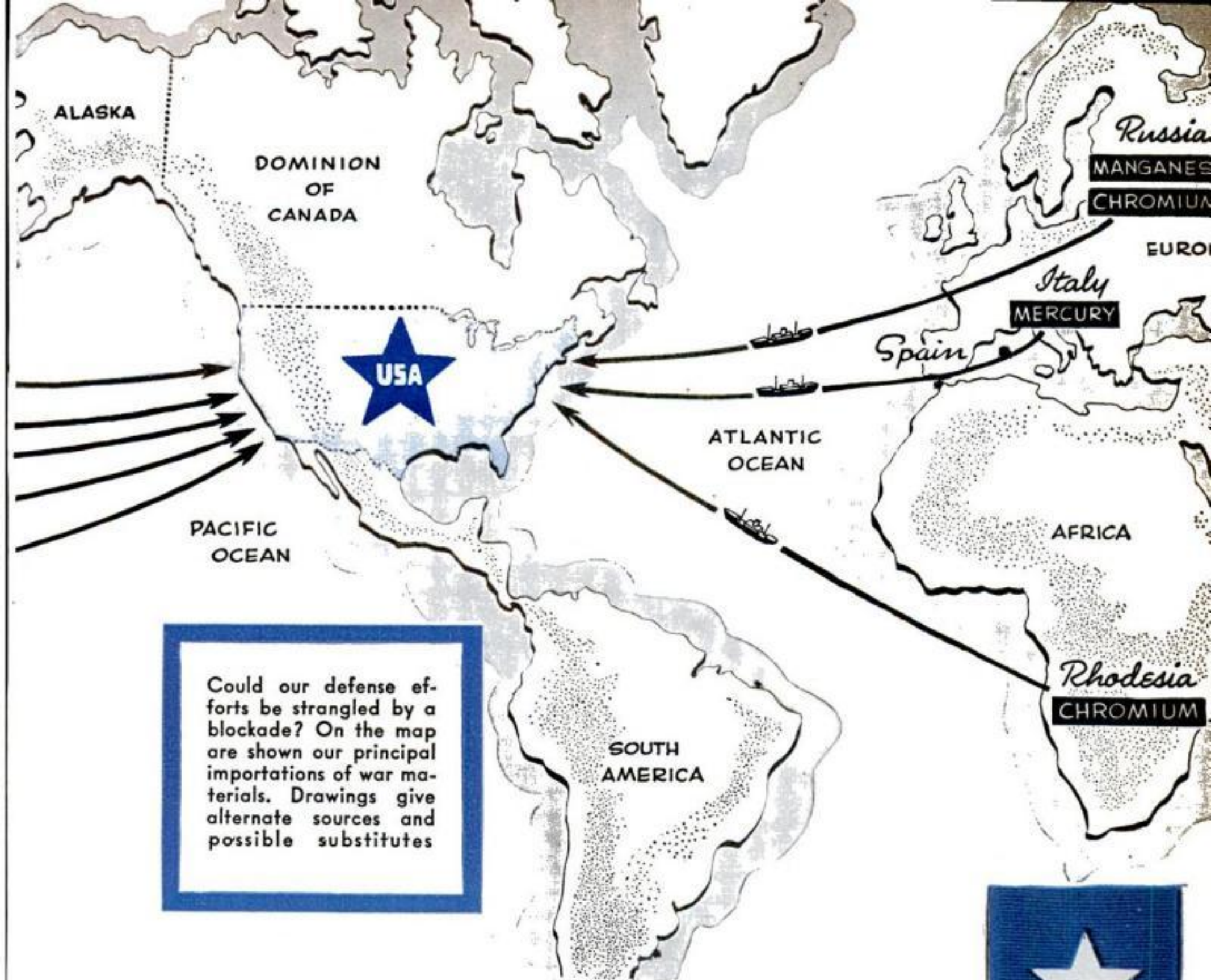
RUBBER

American manufacturers can make synthetic rubber from petroleum



QUININE

Synthetic preparations can replace quinine for medical use



Alexander Goetz of the California Institute of Technology. An alternate proposal suggests substituting bags of Pliofilm, a new synthetic material, for cans.

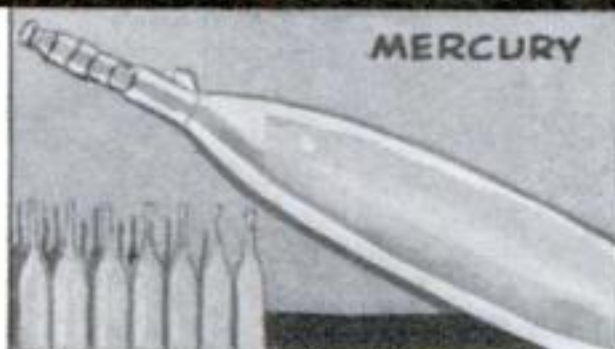
Parachutes made of Nylon, the Du Pont fiber made from coal, air, and water, have been tried out experimentally by the U. S. Army Air Corps and found to function perfectly. They may help to solve the problem of our dependence upon Japan for silk, of which standard 'chutes are fashioned.

Fulminate of mercury, highly sensitive to the slightest shock, has a new rival for use in the detonators of shells and bombs. The substitute, a chemical called lead azide, keeps better and contains no mercury, so the liquid metal may soon be crossed off the roster of strategic materials. Other substitutes have been found for mercuric chemicals in less widely known uses—making blue printing ink, dental rubber, and barnacle-repelling paint for ships' bottoms.

Automobile tires of synthetic rubber, long talked about, now are being marketed in the United States. Instead of making it from coal, as Germany does, American chemists start with petroleum. Thus, mili-



An electrolytic refining process makes American ores available



New sources: U. S., Mexico. Non-mercurial detonating chemicals



New sources of chromium can be developed in U. S., Cuba, Alaska



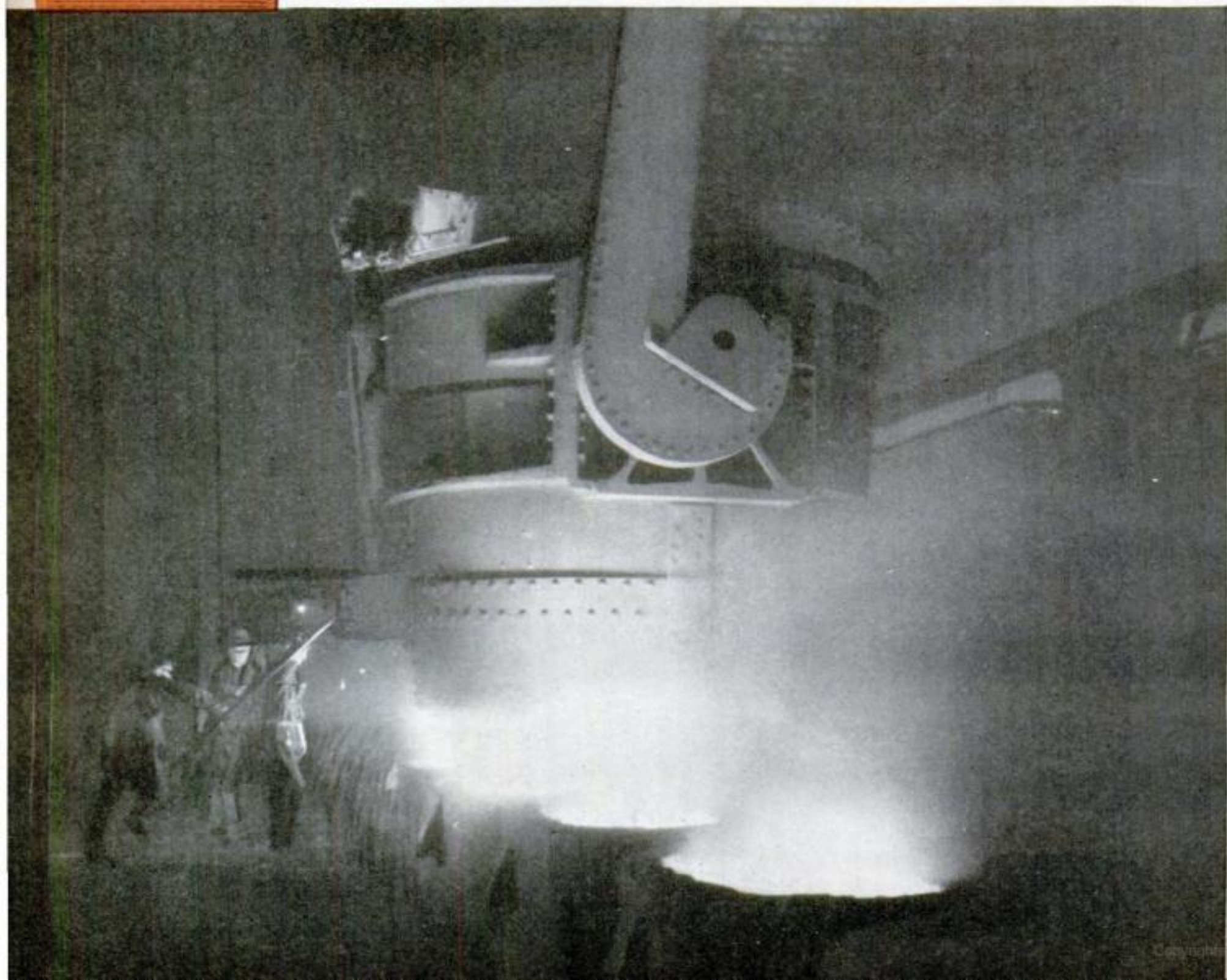
itary vehicles may soon be rolling into battle on tires made from the same raw material that provides fuel for their carburetors. An \$80,000,000 program for expanding experimental synthetic-rubber factories into big mass-production plants has already been initiated, the National Defense Advisory Commission reports.

But it takes precious months to develop mines and to get new factories into production. In a national emergency, could we do it in time? To tide us over that critical period while war industries are getting into high gear, the third and most immediately important part of our strategic-material program is being put into effect.

Gigantic piles of imported war metals and other supplies are being laid in by Government agencies, and stored on military reservations, "for fire use only." Kept intact unless war comes, they would then be thrown into the balance, while new sources were catching up with military demands.

Beginning last year, the United States has been stocking up heavily on thirty-seven strategic and near-strategic materials. Its fast-growing reserve of manganese, intended to fill all war-time needs for a year, results from orders placed in India, Africa, Chile, and at home. The Anaconda Copper Company has contracted to furnish 80,000 tons a year for three years from its Emma mine in Montana. A rising pile of chromium results from orders placed first in Turkey and Alaska. Wherever possible, contracts have been awarded to foster development of United States and Western Hemisphere sources; at the same time, urgent needs must often be filled from far-away countries. Huge international cartels have contracted to furnish us nearly a

Glowing molten metal gushes from an open-hearth furnace to fill ingot molds, as America's steel industry works night and day on defense orders



year's supply of vitally important rubber and tin.

Odd items appear in some of the orders—for instance, tons of quinine, to ward off disease if our soldiers operate in the tropics. Quartz crystals will be needed to keep radio transmitters on the right frequency; in an emergency, they could be flown by plane from Brazil, but the United States is forehandedly laying in plenty for storage.

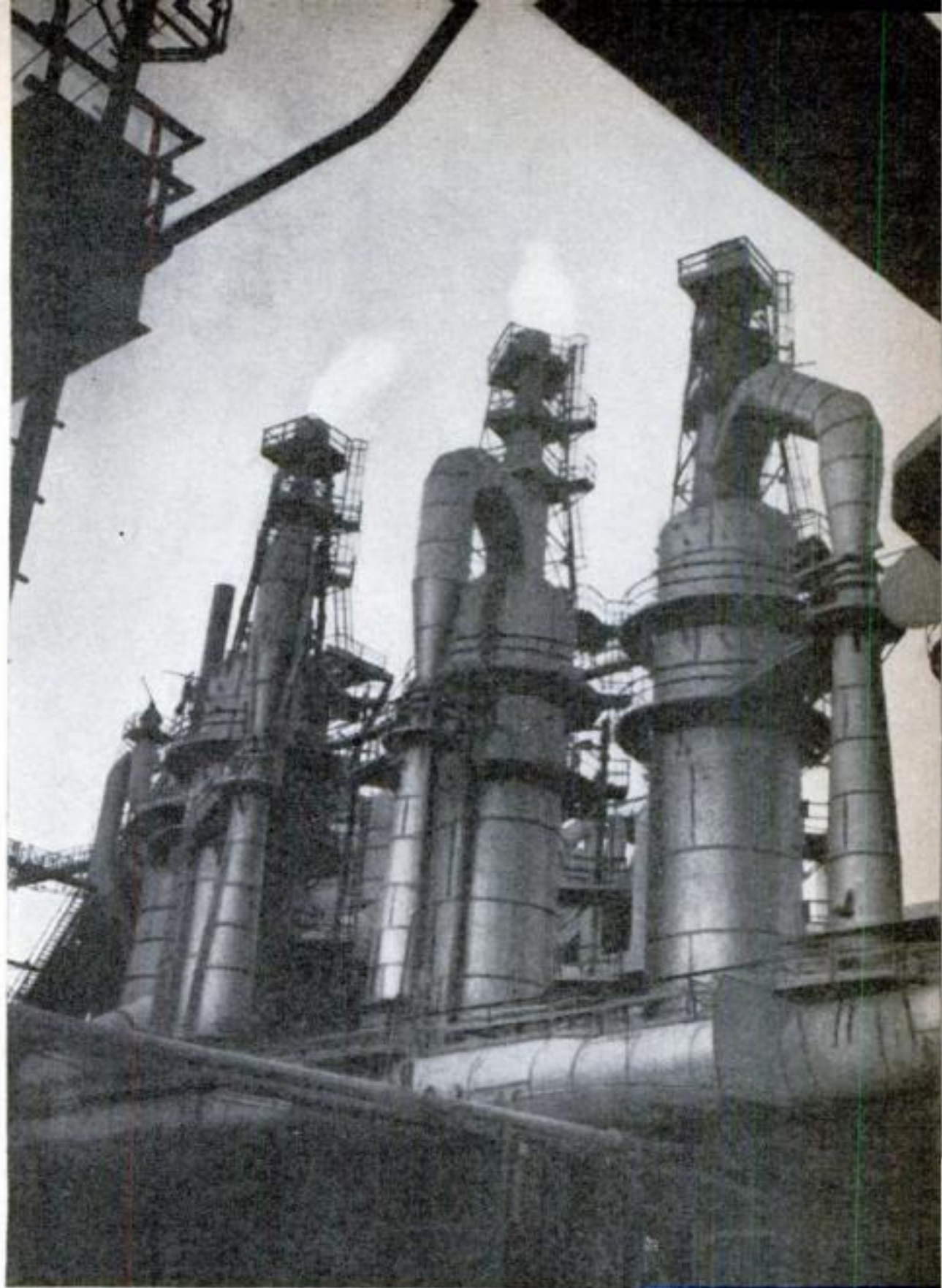
Novel commercial arrangements have been concluded and are under negotiation. We wanted 85,000 tons of British rubber. The English wanted 600,000 bales of American cotton. It was a deal. Despite war difficulties, a large proportion of the rubber has been delivered. At this writing, the United States and Great Britain are working out a plan to store 200,000,000 to 300,000,000 pounds of British wool in this country, subject to purchase for the U. S. Army in case of war. Then it would be made into Army overcoats, and blankets.

So far the story has been of America's weaknesses, and their cure. With these headaches off our mind, we can settle back and comfortably reflect on our strong points. No other country in the world can boast such an enviable assortment of natural resources at home.

Food, most essential of all raw materials in war or peace, isn't one of our defense worries. We raise more than we eat of almost every important foodstuff from apricots to wheat. We won't have to choose between cannons and butter—we can have all we want of both. If war should come, mild rationing of sugar and coffee might be necessary. But our ability to import large quantities of both commodities from Latin-American countries, bordering on the Caribbean, probably would avert even that inconvenience.

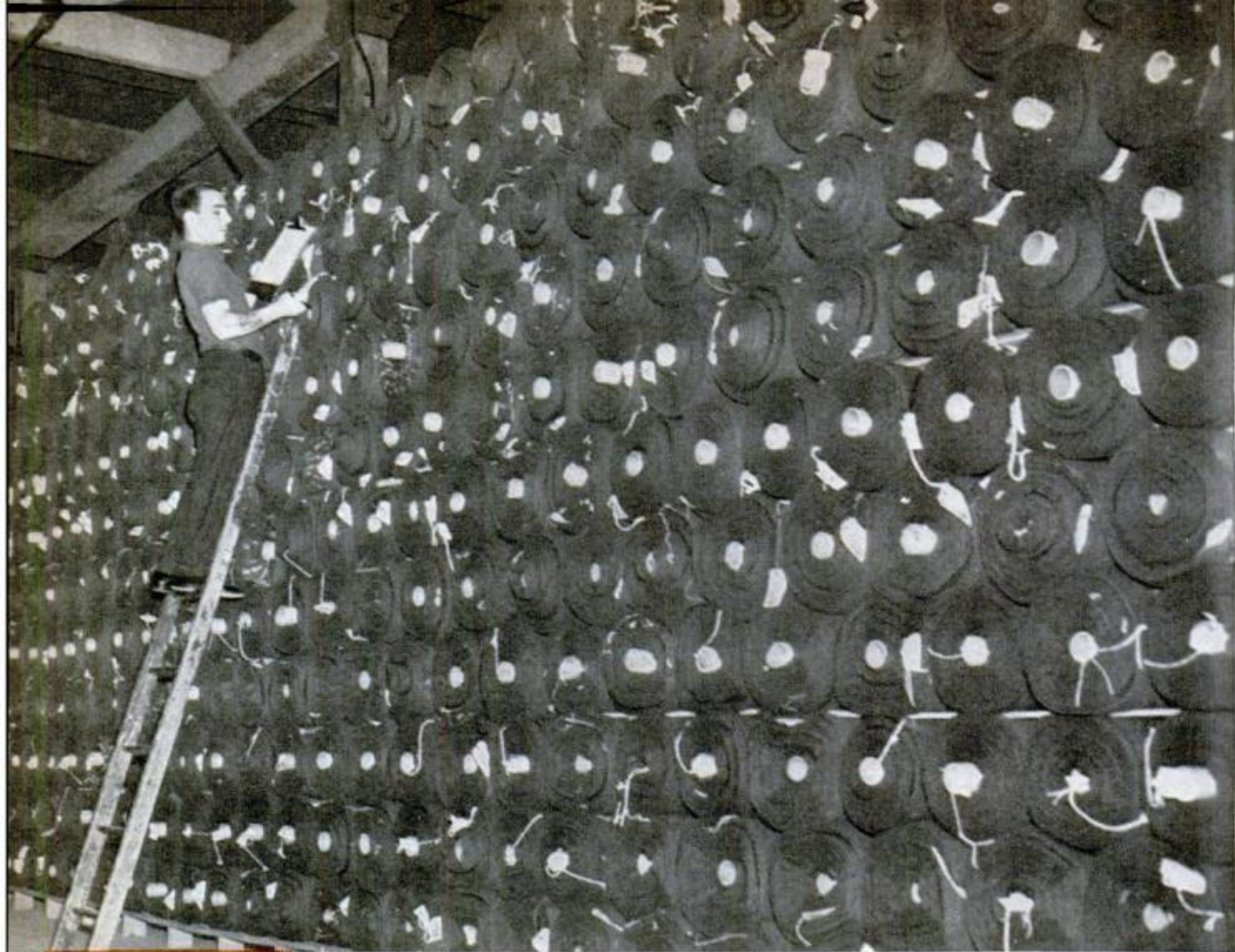
Steel is the great essential of armament, and iron and coal are the principal raw materials used in steel-making. We have enormous reserves of both, and can easily mine enough to meet even the tremendous demands of all-out warfare.

War in the air, the use of oil as fuel for modern fighting ships, and mechanized warfare on land have combined to make petroleum an imperative military necessity. Our resources, greatest in the world, will fill all needs for oil and leave an ample supply for making synthetic products. Large stocks of the comparatively new 100-octane aviation gasoline are being accumulated and stored for Army and Navy air forces.



Blast furnaces like these at Gary, Ind., are going full blast. Steel is the backbone of any armament program and we have the makings of steel: iron and coal





Rolls of cloth for Army uniforms at the Quartermaster Corps Depot in Philadelphia, Pa., where clothing and other equipment is manufactured. Millions of yards of textile materials are being purchased



Besides these principal sinews of war, we have, or are sure of being able to obtain, virtually all the rest—copper, lead, nitrates, sulphur, magnesium, cotton, lumber, to mention only a few. With newly acquired reserves of the ones we have lacked, we are perfecting our armament on the economic front—where undeclared wars may be waged without firing a shot, and where battles may be decided before they are fought.

A tank car of petroleum may be worth a good many bombs, and a few shiploads of iron ore may prove as valuable as a whole squadron of planes, to a country less fortunately endowed with raw materials than our own. Conversely, the nation that has them in abundance is in a commanding position to bid for international advantages, and to wage war or put a brake on it.

The United States embargoes shipments of aviation gasoline outside the Western Hemisphere—ostensibly to conserve our supply, but incidentally denying it to militant Japan. We lend China \$25,000,000, to be repaid by future shipments of tungsten. As Japan gobbles up French Indo-China, America cuts off vital Japanese supplies of scrap iron for warships and armament. To make Brazil independent of Europe for heavy steel, U. S. experts and a \$20,000,000 loan will help build the largest steel plant in South America—freezing out Krupp, the great German armament concern, and other foreign interests.

In tense, dramatic moves upon the chessboard of international politics, raw materials will continue to make big news. Even in peace, America's wealth in them plays a powerful strategic role. And in war, you can strike an enemy as effectively with a lump of manganese as with a bayonet.



"Night Glasses" Train Soldiers To Fight in the Dark

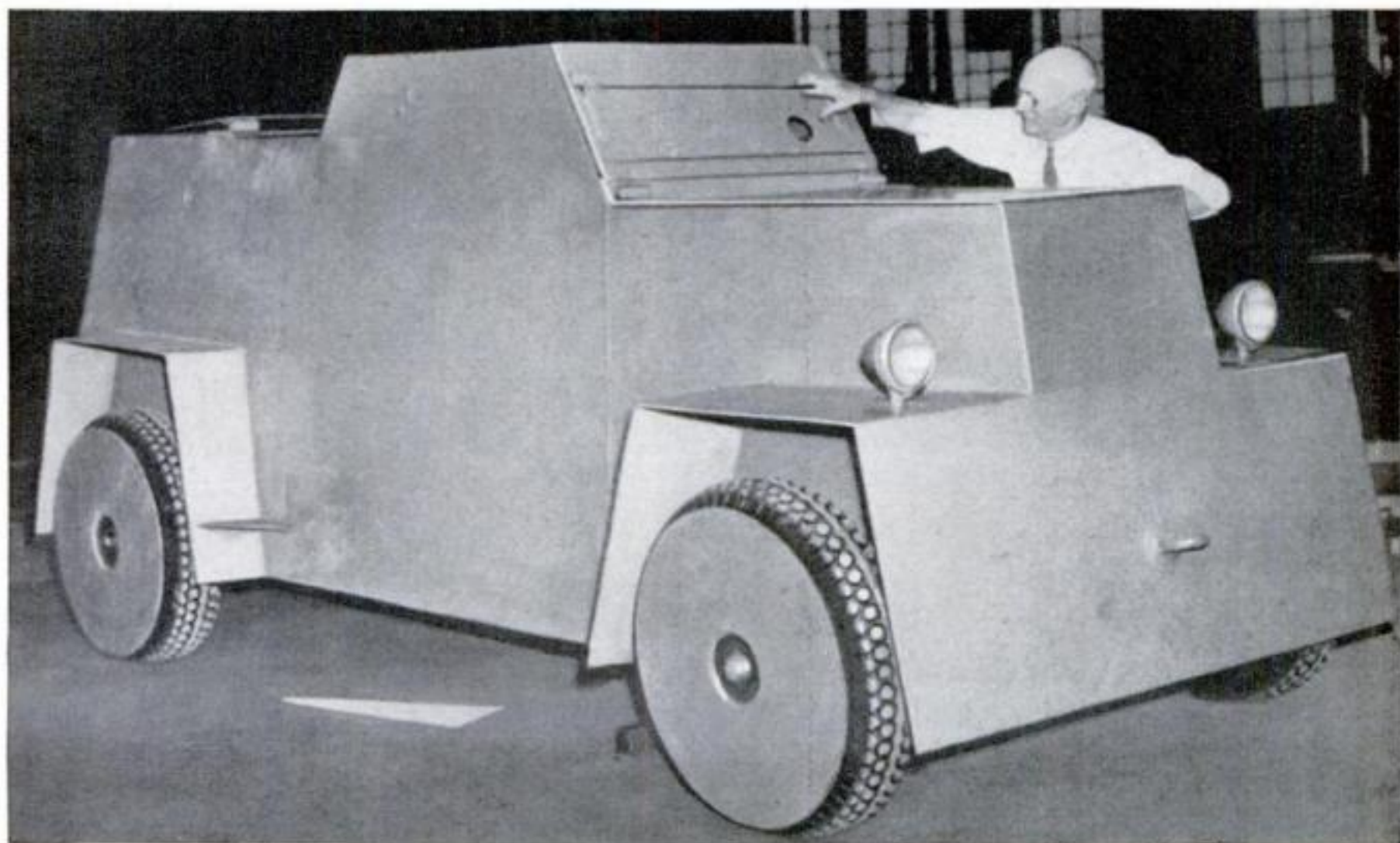
FOR practice in fighting in the dark, cadets in a British officers' training unit wear special "night glasses" during daytime maneuvers. Fitted with dark lenses, the glasses reproduce the visibility conditions that would be encountered at night. In

this way, the young soldiers learn to recognize the landscape as it appears in darkness, and acquire skill in taking "pot shots" when they cannot see their rifle sights. In the photograph above, several cadets are using the glasses which turn day into night.

Bulletproof Body Turns Any Auto into an Armored Car

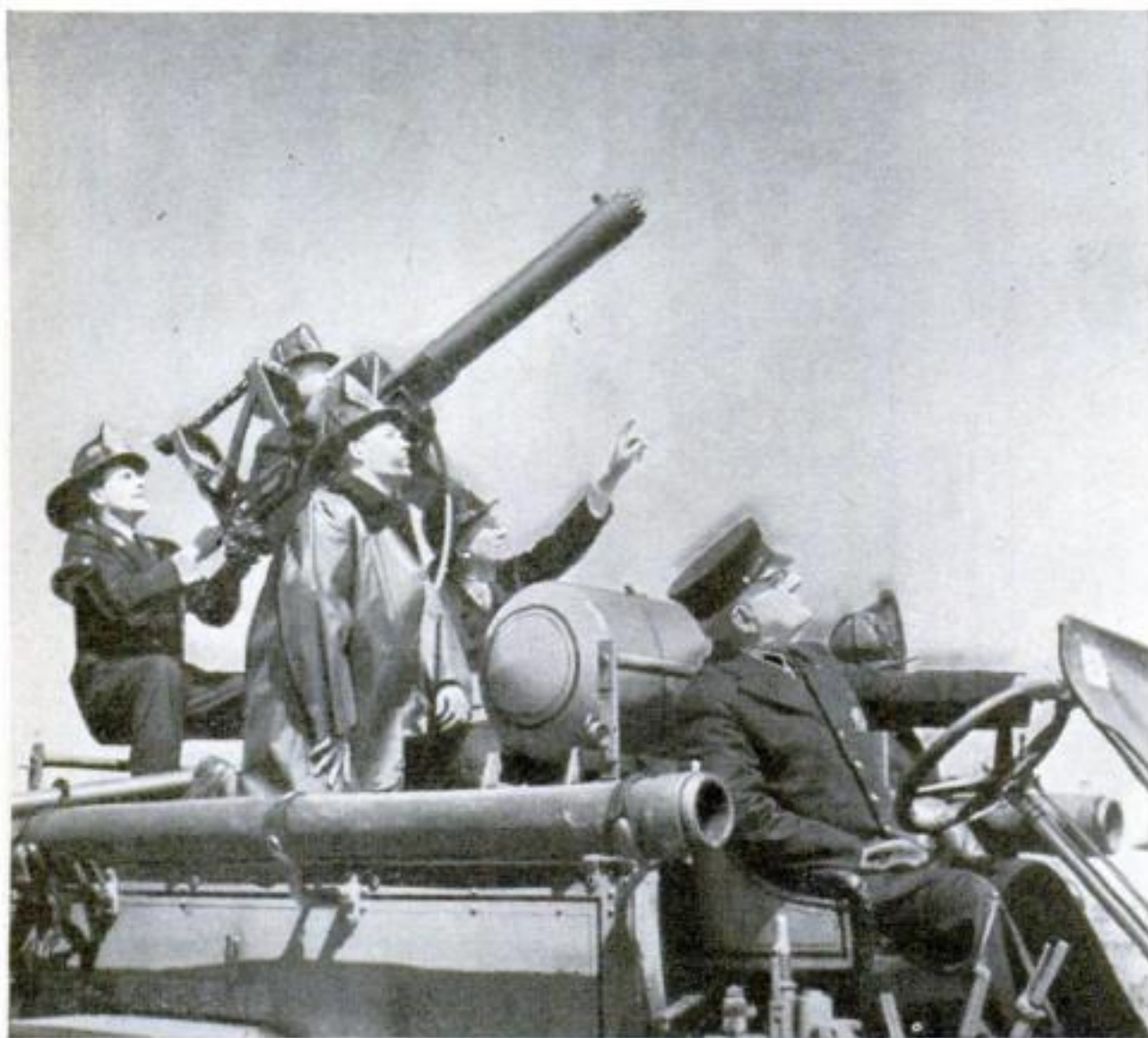
EVERY automobile in the United States is potentially an armored car, under a plan recently proposed to aid the national defense program. The scheme would provide tanklike bodies of half-inch steel which

could be speedily mounted on the chassis of standard cars. Swarms of these "minute man tanks," the proponents claim, would prove an invaluable aid in combating invaders and parachute troops.



This "minute man tank" was made by mounting a body of half-inch steel on a standard automobile chassis

Firemen Learn To Fight Air Raiders as Well as Fires



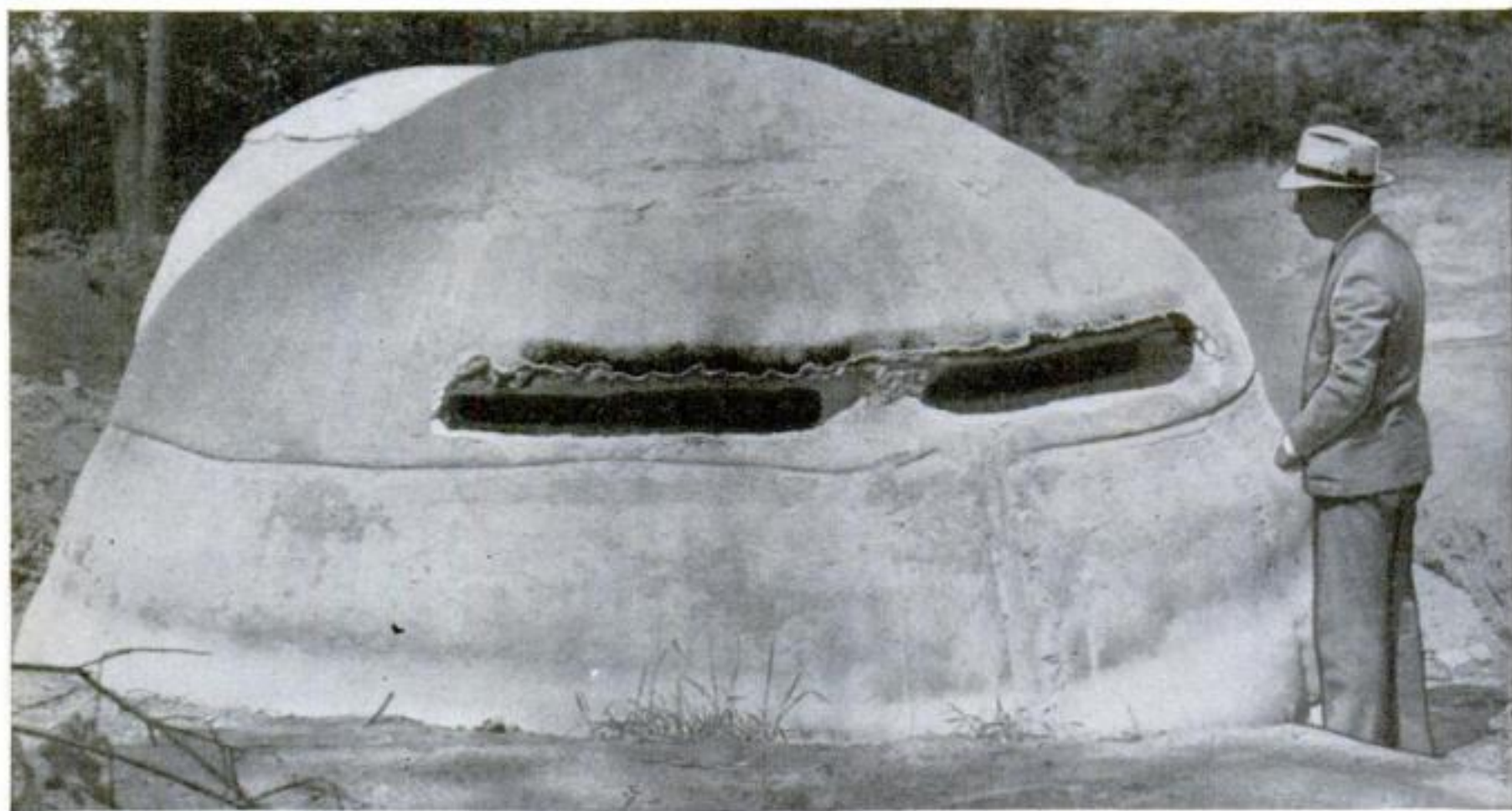
Boston smoke eaters aiming an anti-aircraft machine gun instead of a hose

BY MOUNTING an anti-aircraft gun on a fire engine, smoke eaters of Boston, Mass., recently demonstrated how their force could cope with an enemy air raid. Now plans are reported to arm a number of other fire trucks similarly, and to train gunners with the coöperation of the National Guard. In case the firemen were attacked by low-flying raiders, while putting out a fire started by air bombs, the powerful machine gun would provide an effective defense. Other engines, roaring along highways with sirens shrieking, would serve as mobile anti-aircraft units exclusively, supplementing the work of regular military defense units.

Concrete Pill Box or Bomb Shelter Is Built in a Day

CONCRETE pill boxes may be erected in a single day, by a speedy new method exhibited to War Department observers at New Haven, Conn. The structures may be used either as fortresses, or as bombproof

shelters during air raids. A biscuit-shaped design found most suitable for the purpose, shown in the illustration below, measures fourteen feet in diameter and has walls a foot and a half thick.



In an emergency, structures like this can be erected quickly for use by either soldiers or civilians

All-Purpose Gun Guards Airport from 'Chutists

SPECIALLY designed for defending military airports against attack by enemy parachutists, a portable all-purpose gun tested recently at Floyd Bennett Field, New York City, fires tear-gas and smoke shells, parachute flares, and one-pound fragmentation bombs. Projectiles are placed in a twelve-shot magazine resembling a revolver cylinder, which can be changed in three seconds for reloading. Weighing only forty pounds, the versatile weapon has a barrel of 1½-inch bore and can be folded up quickly for carrying. It is believed that a few of these guns could ward off any parachute attack.



Portable airport-defense gun with its twelve-shot magazine cylinder removed. At the left are three kinds of projectiles it fires: one-pound bomb, tear-gas shell, and parachute flare



The 1½-inch weapon set up for action. Weighing only forty pounds, it folds up quickly for carrying

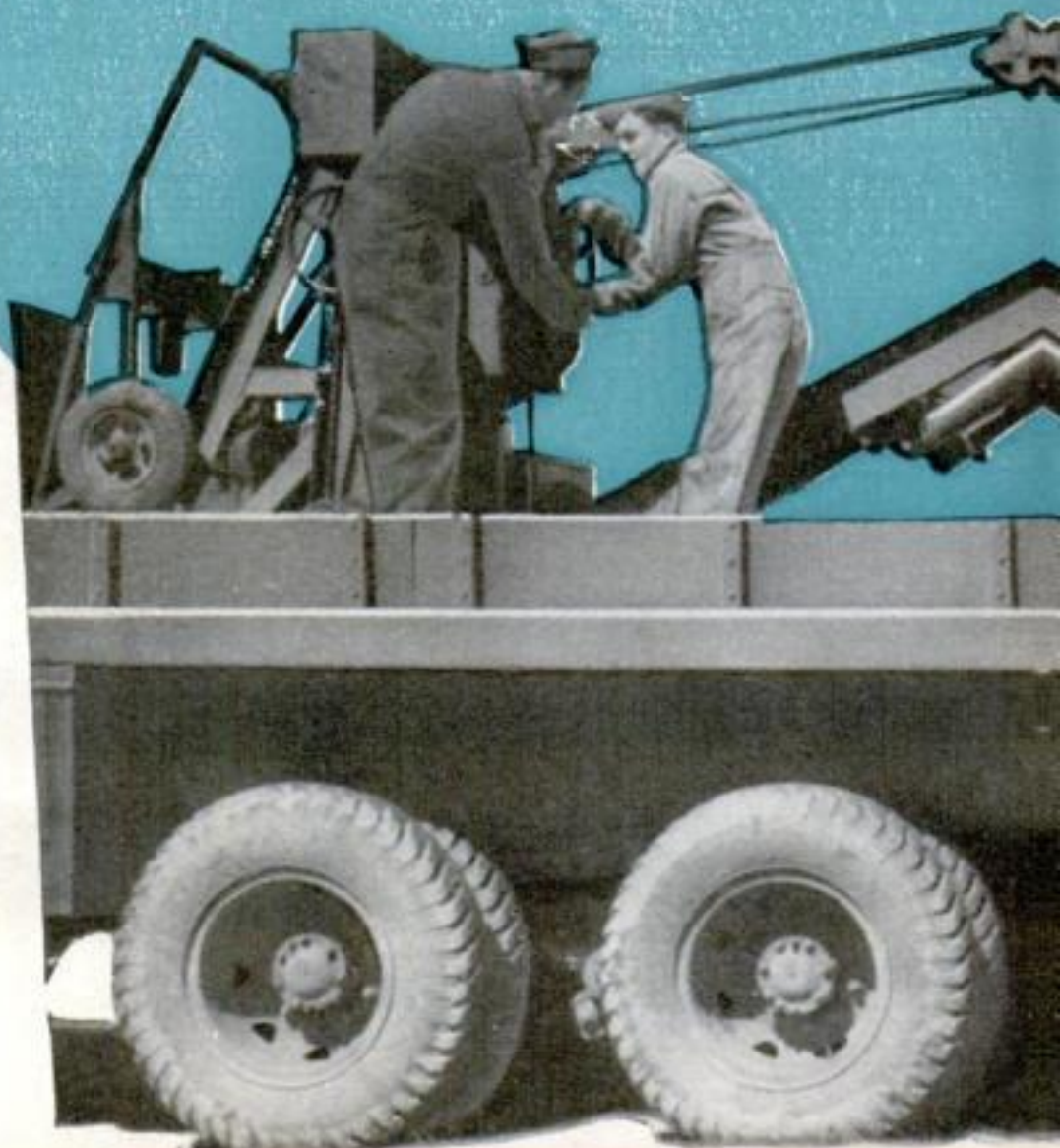


Soldiers in Overalls

KEEP OUR WAR MACHINE ROLLING

AN ARMY officer who has what it takes can make dead-tired men march all night and attack in the morning, and he can make scared-stiff men fight and win when the odds are all against them. That's leadership—the most valuable quality that an officer can have. But even the best leadership can't make a tank run on a broken track or get mileage out of a scout car with a cracked cylinder. It can't grind the valves of an ammunition truck, repair a broken-down machine gun, or weld the cracked axle of a howitzer. Those are jobs for trained and skilled mechanics—for the soldiers in overalls who keep the Army's fighting machines running.

While our Army still is dangerously short in the quantity of its mechanized weapons, it is long on their quality. Our light tanks, developed by the Ordnance Department, are rated the world's best. They have better engines, better drives, better transmissions, and better tracks than any other light tanks; they are heavier, faster, and steadier gun platforms. When it comes to the quality of their fighting vehicles, and their sys-



tem of keeping 'em rolling, our mechanized soldiers don't have to take off their snappy barrack caps to any army in the world.

One of the purposes of the Third Army maneuvers in western Louisiana this spring was to give our Regular Army officers their first large-scale opportunity of practicing the tactics and solving some of the problems of mechanized, motorized, and modernized warfare. The maneuvers also provided a stiff test of the Army's services of maintenance and supply. The mimic war meant two weeks of the hardest kind of work for the 70,000 Regulars who took part in it—especially for the men who had the job of keeping rolling the over 7,000 motor vehicles which were driven hard both on the roads and off them. There was plenty of sweating done—but then, as China's General Chiang Kai-shek says, "the more you sweat in peace, the less you bleed in war."

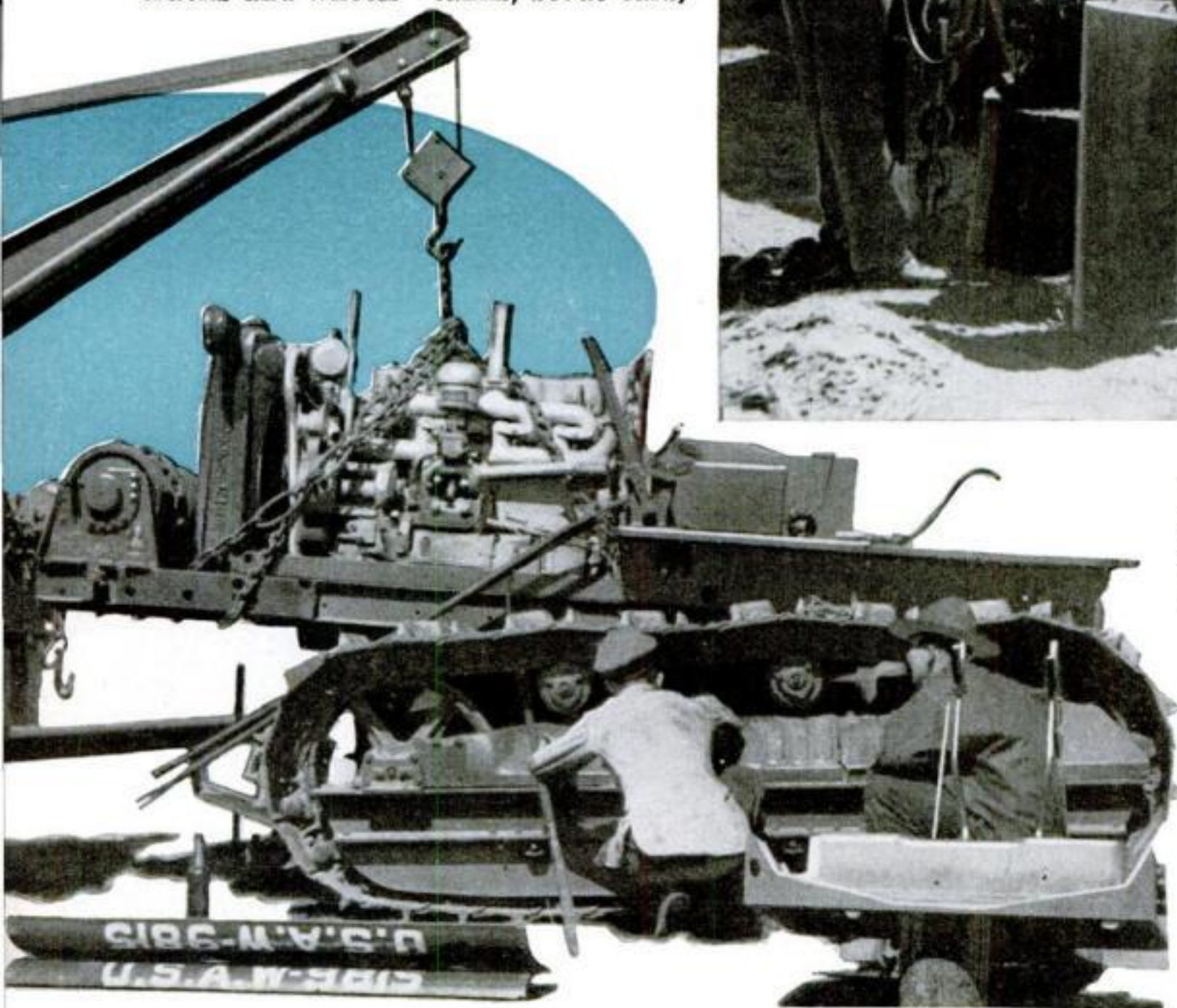
Following the light tanks of the Mechanized Cavalry Brigade—then the most thoroughly mechanized outfit in our Army—as they thundered over the big maneuvers area on their scouting and combat missions, I was able to get a close-up of the operation of the maintenance system of an organization which had 720 vehicles on tracks and wheels—tanks, scout cars,

half tracks, trucks, passenger cars, and motor cycles—and which regards attacking at daybreak 150 or 200 miles away from where hostile aviation reported it at dusk as just another routine job.

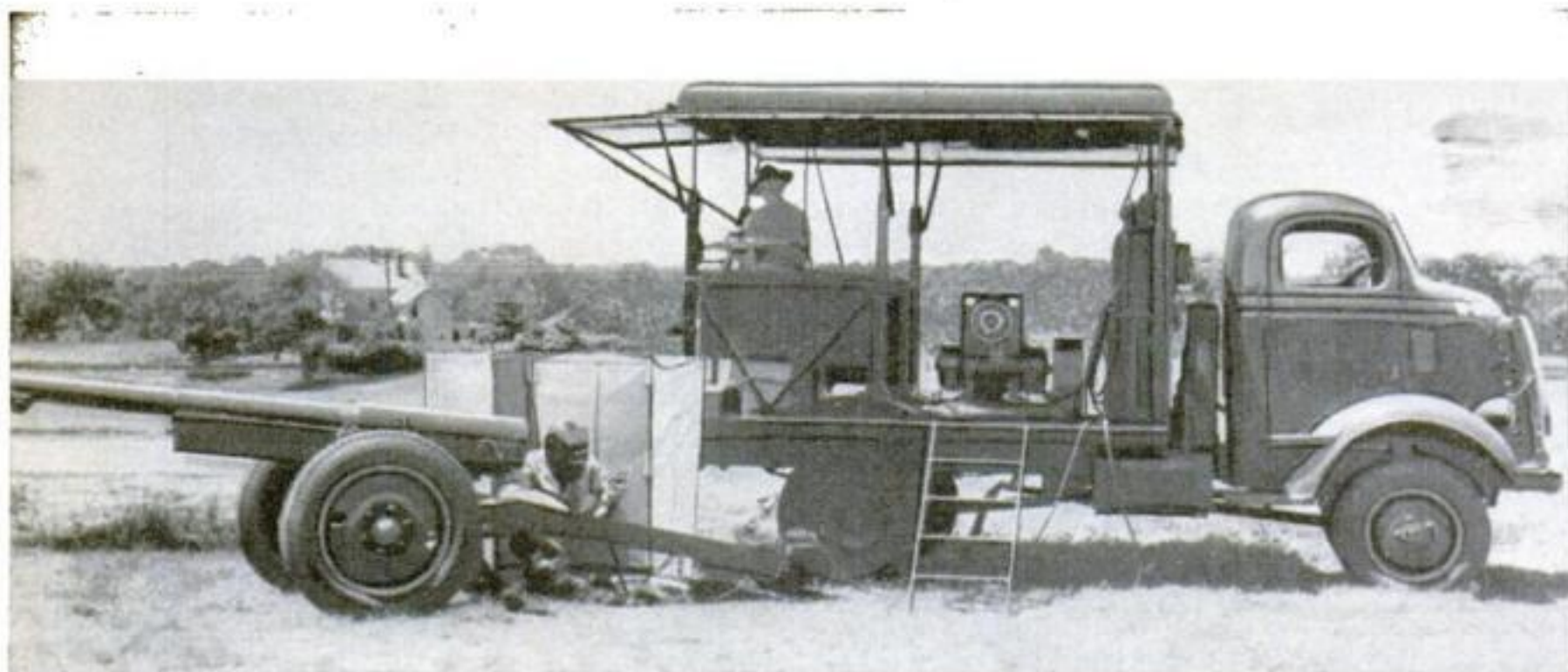
Each troop has a maintenance section which stays with it under all conditions to make minor repairs both on the road and on the battlefield. It is commanded by a motor sergeant who is an expert trouble shooter and travels in an armed scout car followed by a truck which carries light repair equipment, a small assortment of spare



Vulcan's forge, 1940 style: a field welding shop in action. It follows the "iron cavalry" in a truck



A big repair job on a tractor is all in the day's work for field maintenance men. Spare parts and all necessary tools and equipment are carried

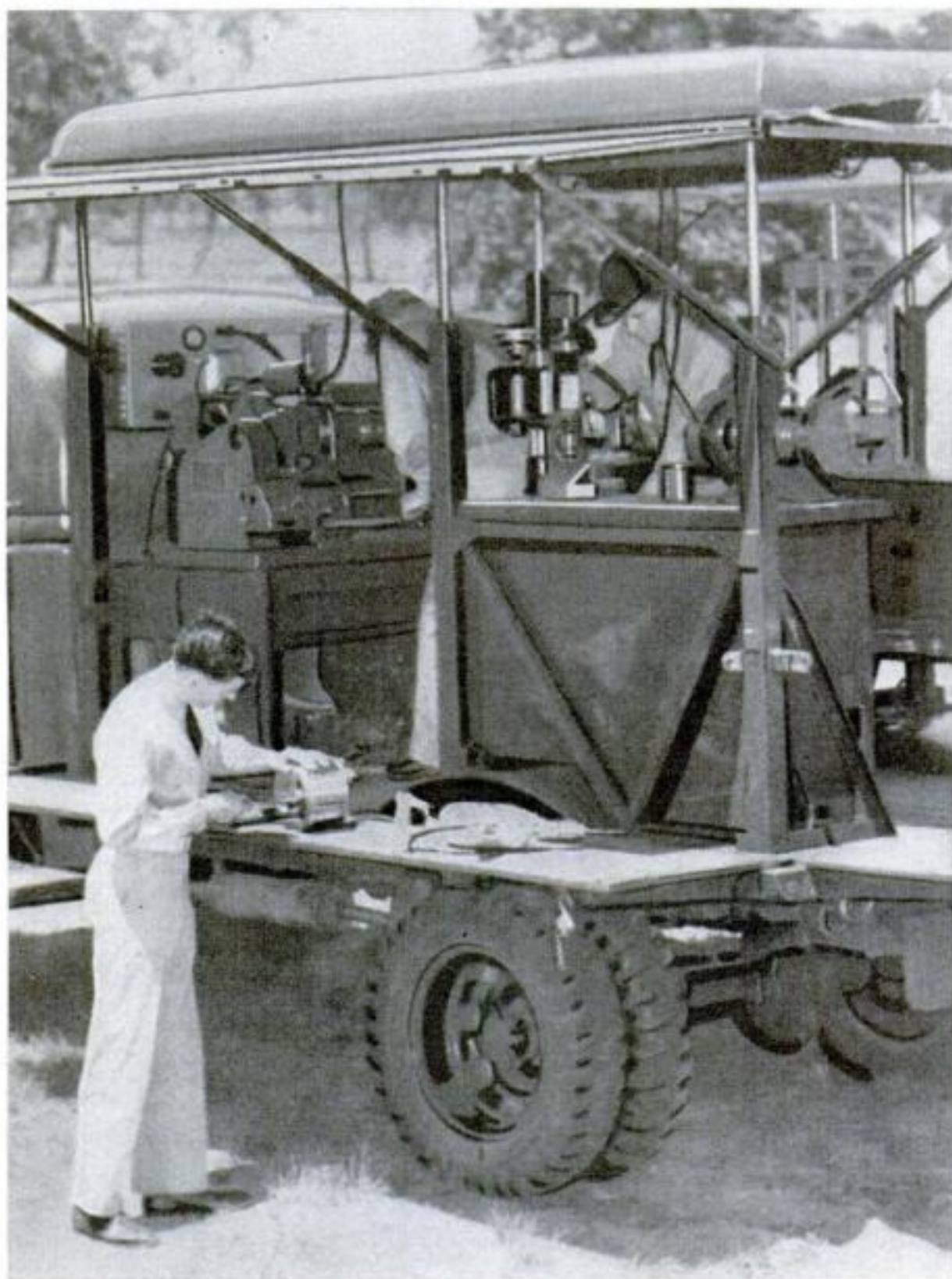


A welding truck halts to repair the carriage of a field gun. Its generator provides current for welding and to drive its power tools. At right, an automotive repair-shop truck

parts, and an emergency supply of gasoline and oil. When a tank or scout car is disabled it is pushed over to the side of the road and the rest of the troop goes on forward to fight. It is an unbreakable rule that the officer in command must not wait for cripples.

When the troop maintenance section comes up, the motor sergeant checks the disabled vehicle and diagnoses the trouble. If he has the time and equipment for the job he makes the repair, takes the vehicle along with him to the next halt, and then sends it forward to rejoin the troop. If he can't make the repair, he tags the job with his diagnosis, and leaves it. Its crew always stays with a disabled tank or scout car, so that as soon as it has been repaired they can take it back into action where it belongs.

Following the regiment on the march is the regimental maintenance section, which carries with it a larger assortment of spare parts and is equipped to handle jobs such as changing tank tracks and installing new shaft assemblies. When it comes up to a



disabled fighting vehicle the staff sergeant who is its chief mechanic rechecks the job, and if an immediate repair is practicable leaves a crew to make it. If a roadside repair can't be made, he has a wrecker tow the cripple to where the regiment is going to bivouac for the night, and the

repair is made there. When there is fighting going on, a regimental service park is established a few miles back of the combat zone. Disabled vehicles are reported to it by radio, and crews are sent out to repair them on the battlefield or to tow them in.

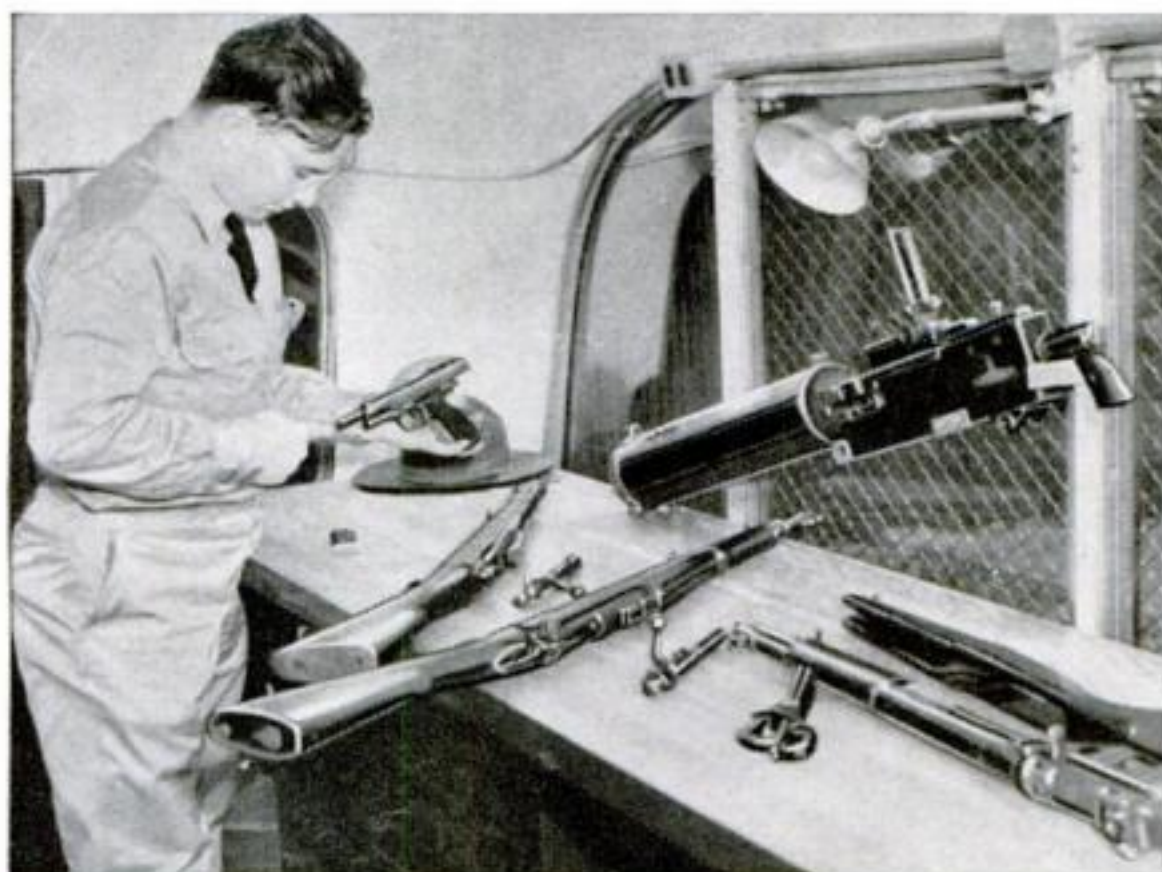
Jobs which are too big to be handled by the regimental maintenance sections are taken over by the brigade's ordnance maintenance company, which has machine-shop trucks, welding apparatus, and other equipment which, while sturdy, is light enough to be carried in trucks. This organization can handle almost any repair job, even that of installing a new engine. It takes with it into the field two complete engine assemblies for each fifty tanks. Its 200-odd highly-trained soldier-mechanics set up

their shop in a big square tent brightly lighted by electricity supplied by a generator truck. Often they work all night to make good on their boast that, if it is humanly possible, they always have every disabled vehicle ready to go when the column pulls out in the morning.

There will be one of these maintenance companies, probably increased in manpower, in each of the two divisions of the new Armored Corps now being organized. Men now are being trained to do this specialized mechanical work of the Army's most modern fighting outfit at schools recently established at Fort Benning, Ga., and Fort Riley, Kans.

As important as keeping a mechanized force's fighting vehicles in perfect mechanical condition is the job of keeping them

supplied with fuel. There's nothing in war more useless or more helpless than a tank with an empty gas tank. Having a supply of fuel at the right place at the right moment always demands careful planning and often demands hard work. Tank trucks have been tried and discarded. Now cargo trucks carry the fuel in ten-gallon cans which, while the column is halted, are dropped off at each vehicle. This method saves time, and time is the



Interior of a small-arms repair truck which keeps rifles, pistols, and machine guns in good order



The Quartermaster Corps handles the big job of feeding gasoline to the war machines. This is a field depot where fuel is put into ten-gallon cans for distribution by truck to hungry tanks and tractors

determining factor in today's warfare.

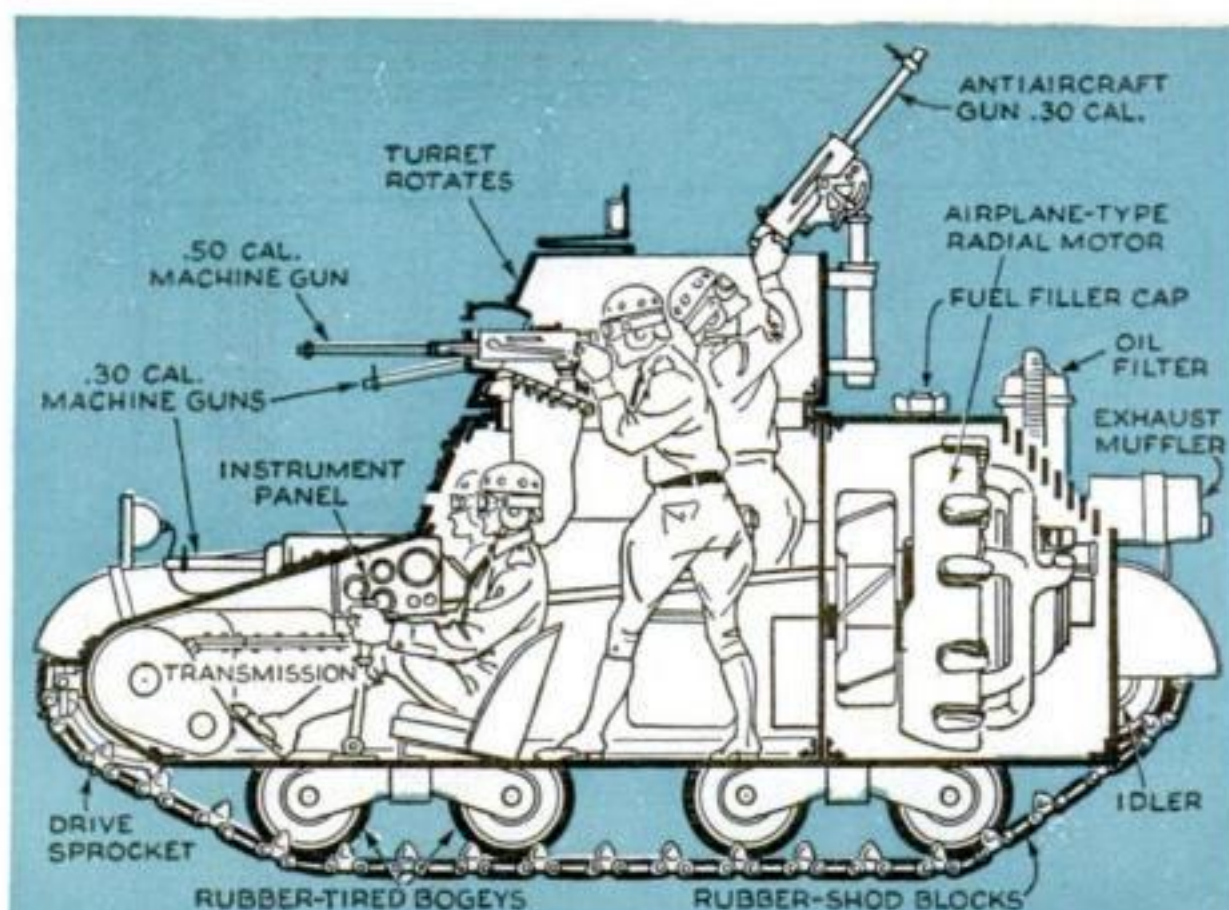
Attached to each of the two army corps we now have organized there is a corps ordnance battalion, and equipment is being procured for additional battalions so that as the expanding Army adds new corps there will be a battalion for each of them.

Each man in these battalions is trained to expertness in some mechanical operation. After he has mastered that particular job he is trained to handle other jobs. All the equipment is carried on trucks, and most of it is used on them, so the field shops are ready for work a few minutes after the trucks have scattered through some patch of woods which will give them cover against air attacks. Included in the equipment are field welding outfits, machine-shop trucks, and special firearms-repair trucks which carry extensive assortments of spare parts and the tools necessary for the repair of machine guns, rifles, and pistols.

One of the jobs I watched being done dur-

ing the Louisiana maneuvers was the welding of the broken axle of a 155-millimeter howitzer, without taking the big weapon out of its firing position.

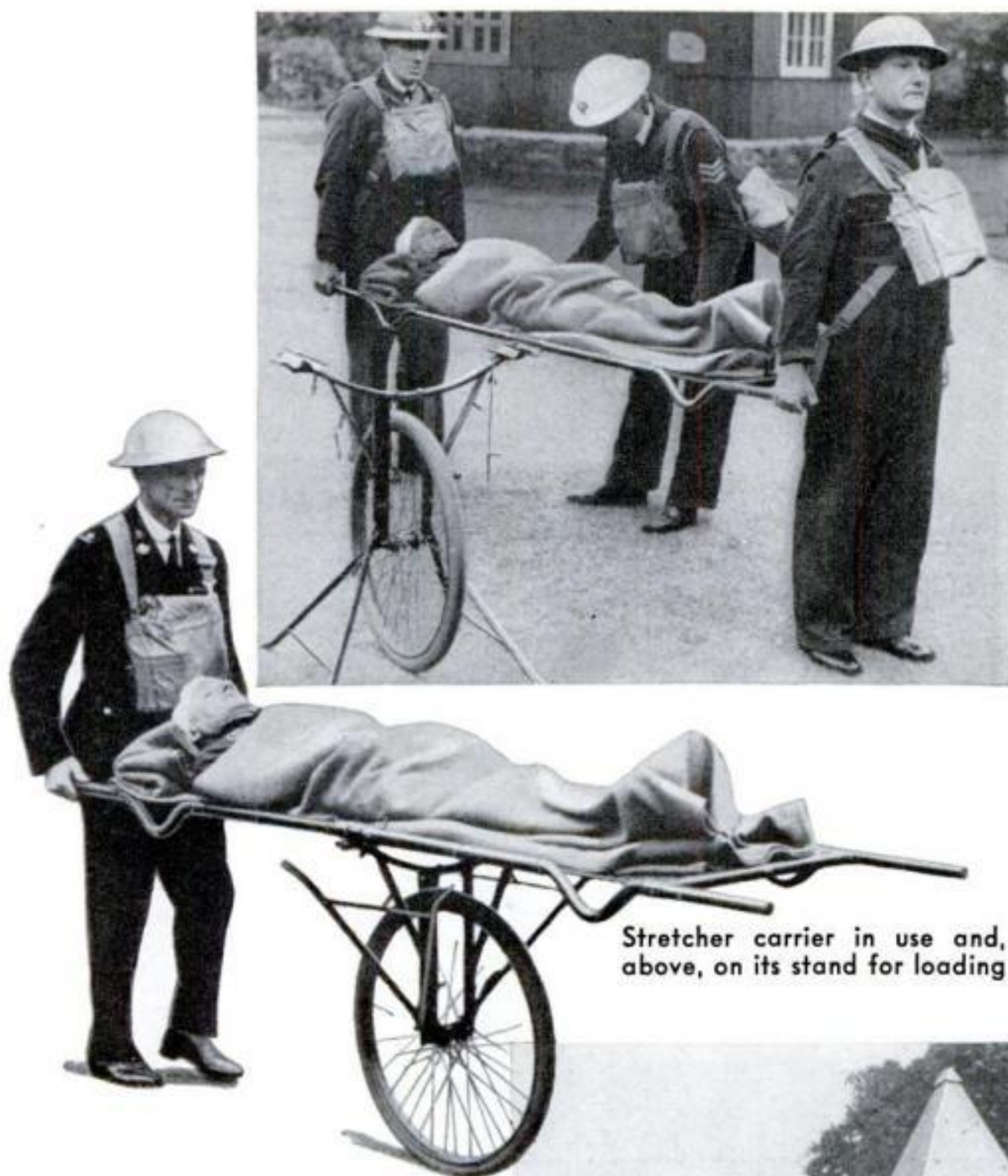
In its various post shops the Ordnance Department has sturdy but comparatively light machine-tool equipment capable of doing all the work of a large job shop. In war this would be taken into the field and used by ordnance *(Continued on page 232)*



Uncle Sam's light tanks are generally rated the best in the world. The cut-away view shows one of them with its four-man crew at its post



Trucks and other non-fighting vehicles are kept in running order by the Motor Transport Service



Stretcher carrier in use and, above, on its stand for loading

Stretcher Holder With One Wheel Speeds Rescues

ONE man can trundle an injured person to an ambulance or first-aid station on a one-wheel stretcher carrier designed for use in air raids. Built to fit a standard stretcher, the device uses a bicycle wheel and has a stand to support it when the stretcher is removed. Since it can be operated like a wheelbarrow, the carrier enables a single worker to take the place of two men in moving bomb victims, speeding rescue work in cases where ambulances cannot be brought right up to the scene of the damage, or when a first-aid station is set up near-by.

Mass-Production Air-Raid Shelter Made in the U.S.

APPROPRIATELY shaped like an Indian tepee, what is said to be the first bomb shelter to be produced commercially in the United States was placed on display recently at Quincy, Mass. Made of quarter-inch reinforced steel, the pyramidal hide-out is not intended to withstand direct hits, but is said to be capable of protecting five or six occupants from flying debris. Mass production may soon be started on the shelter, which is a copy of a popular-priced English model that has proved very effective.



Not a play tent, but a demonstration model of an American bomb shelter

Squadrons Right!

HOW WARSHIPS MANEUVER IN BATTLE

WHEN the crackling radio report from advanced scouting ships or planes sends a battle fleet out to sea in search of the enemy, how does the Admiral handle his floating fortresses? How do they advance into battle? What formations do they take, and what maneuvers do they follow?

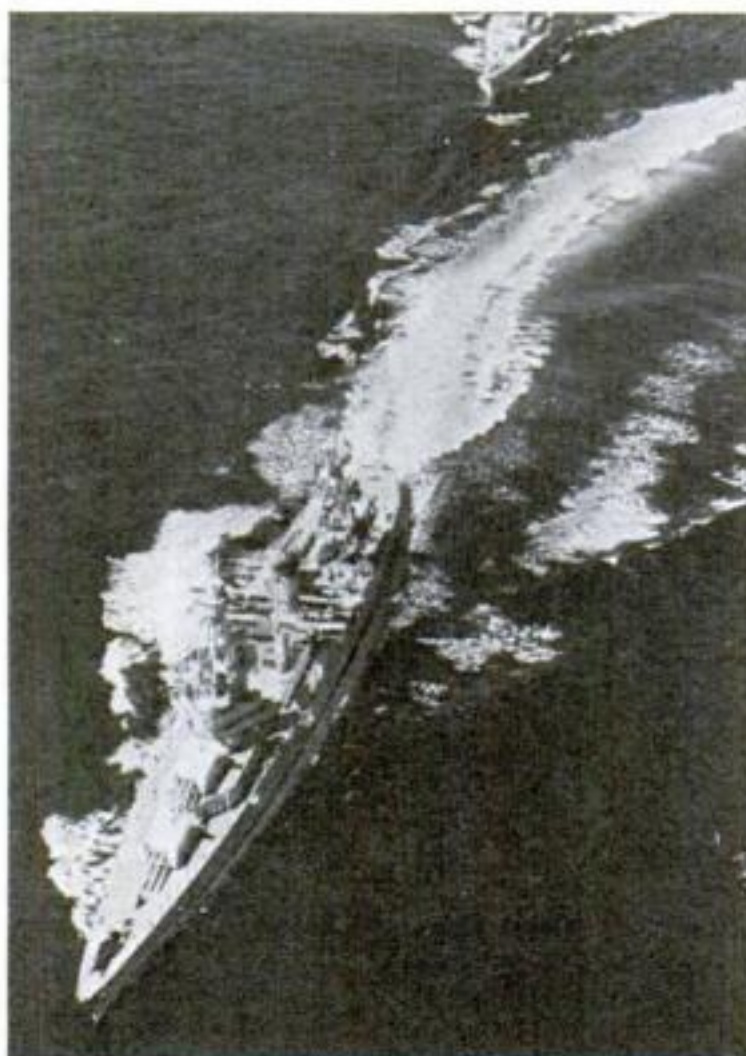
As far as they relate to America's mighty armada, detailed answers to these queries are the jealously guarded secrets of the commanders who have been putting our battle forces through their paces in long drills at sea. No one outside of official circles knows the specific maneuvers that the U. S. Fleet will follow if it is called upon to steam seaward to protect our coasts or repel a threat directed at the Panama Canal.

But certain formations and maneuvers are standard among all navies,

only the combinations and elaborations of them for specific purposes being kept under cover. In the words of Winston Churchill, twice First Lord of the British Admiralty:

"The evolutions of cavalry in the days of shock tactics and those of a modern fleet resemble each other . . . both cavalry and fleet drill consist primarily in swift and well-executed changes from one formation to another."

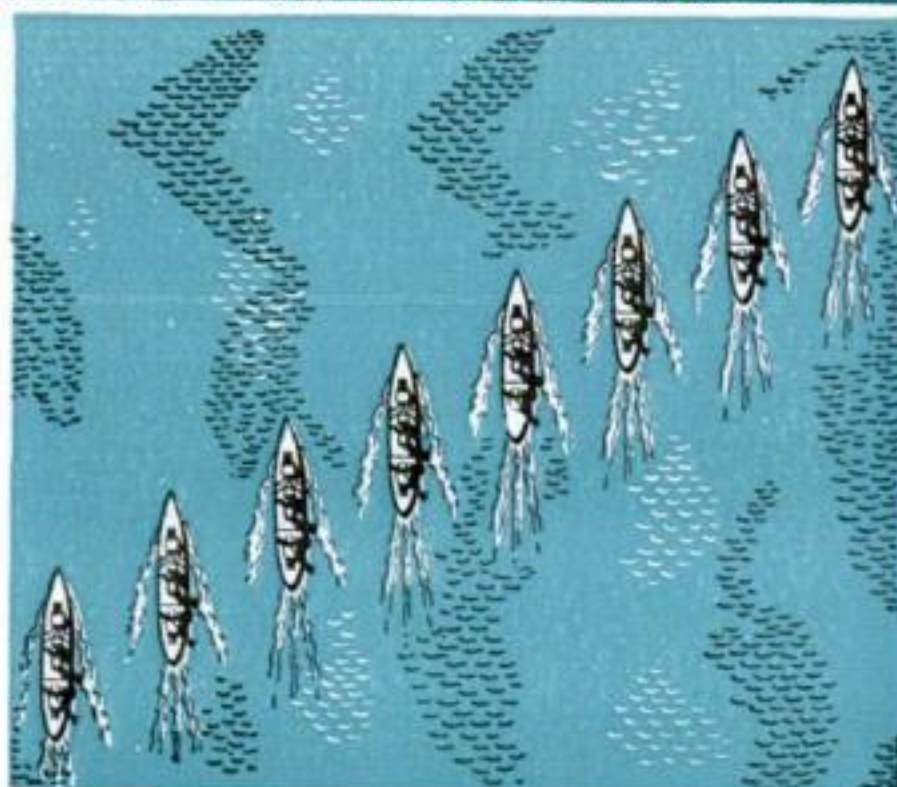
The basic tactics, he continues, call for a fleet to approach in a compact mass, and then deploy into a long column to fight so that all guns can be trained over one side for a withering blast at the enemy. The diagrams on this and the following pages illustrate some of the major formations and maneuvers used by battle fleets to gain a tactical advantage over their opponents in the deadly game of war at sea.



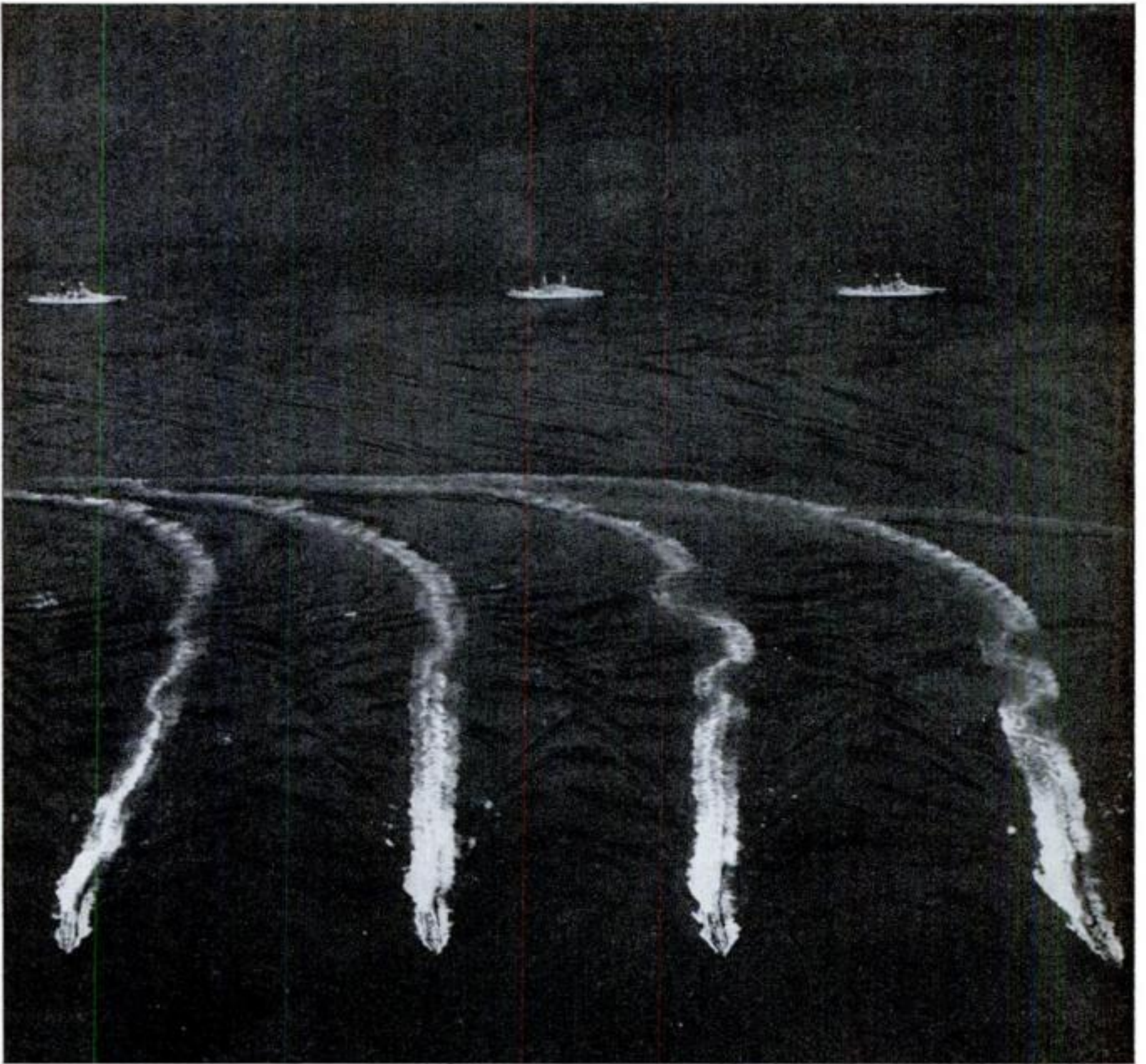
THESE ARE STANDARD CRUISING



SHIPS IN COLUMN. In actual battle, this formation enables all the ships to bring their broadsides to bear simultaneously on the enemy

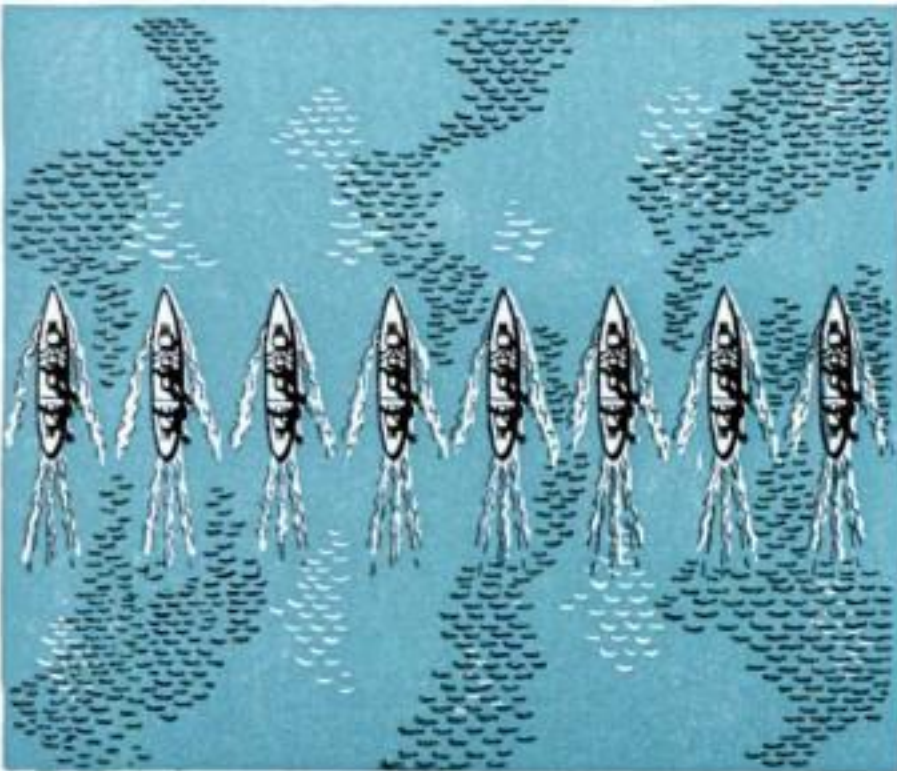


LINE OF BEARING 45 DEGREES. Here the ships are steaming on parallel courses, with one end of the line far in advance of the other

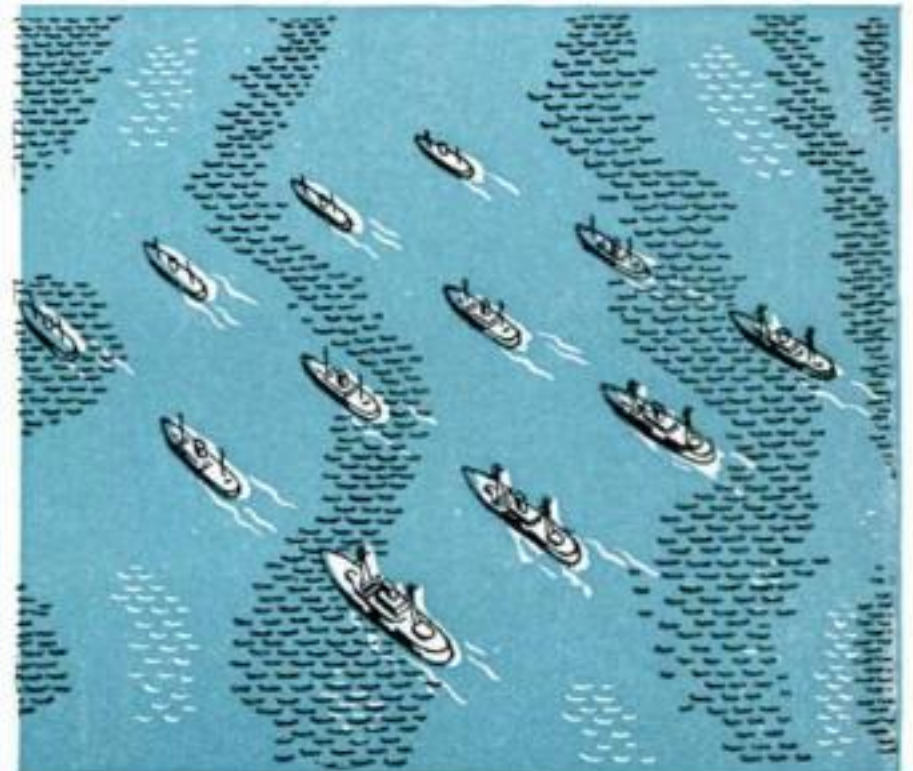


Leaving tracks of foam, U. S. warships on maneuvers execute a neat turn from column formation into line

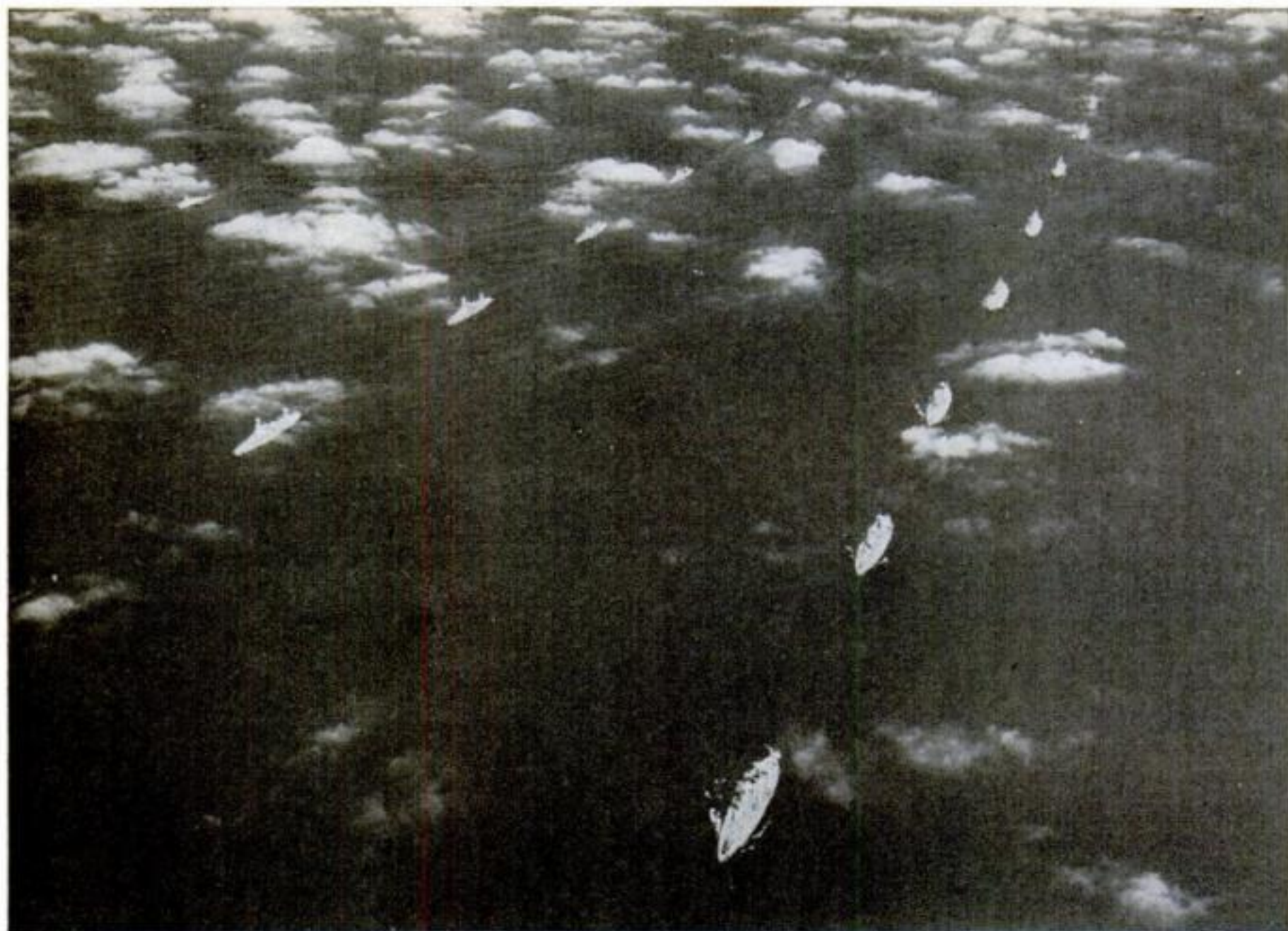
FORMATIONS OF A BATTLE FORCE



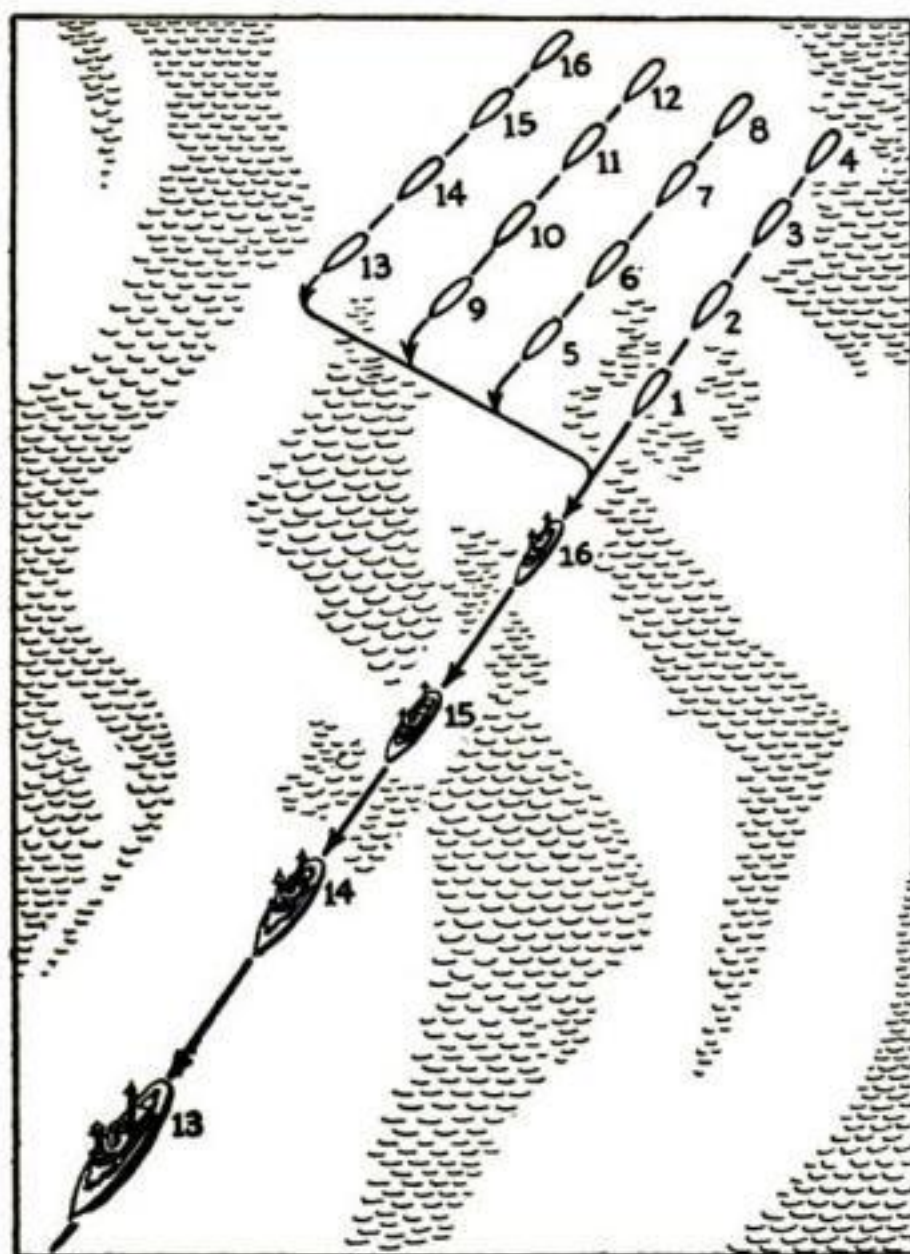
SHIPS IN LINE, or line of bearing 90 degrees. This formation can be used for approach, but it would be fatal to be caught so under fire



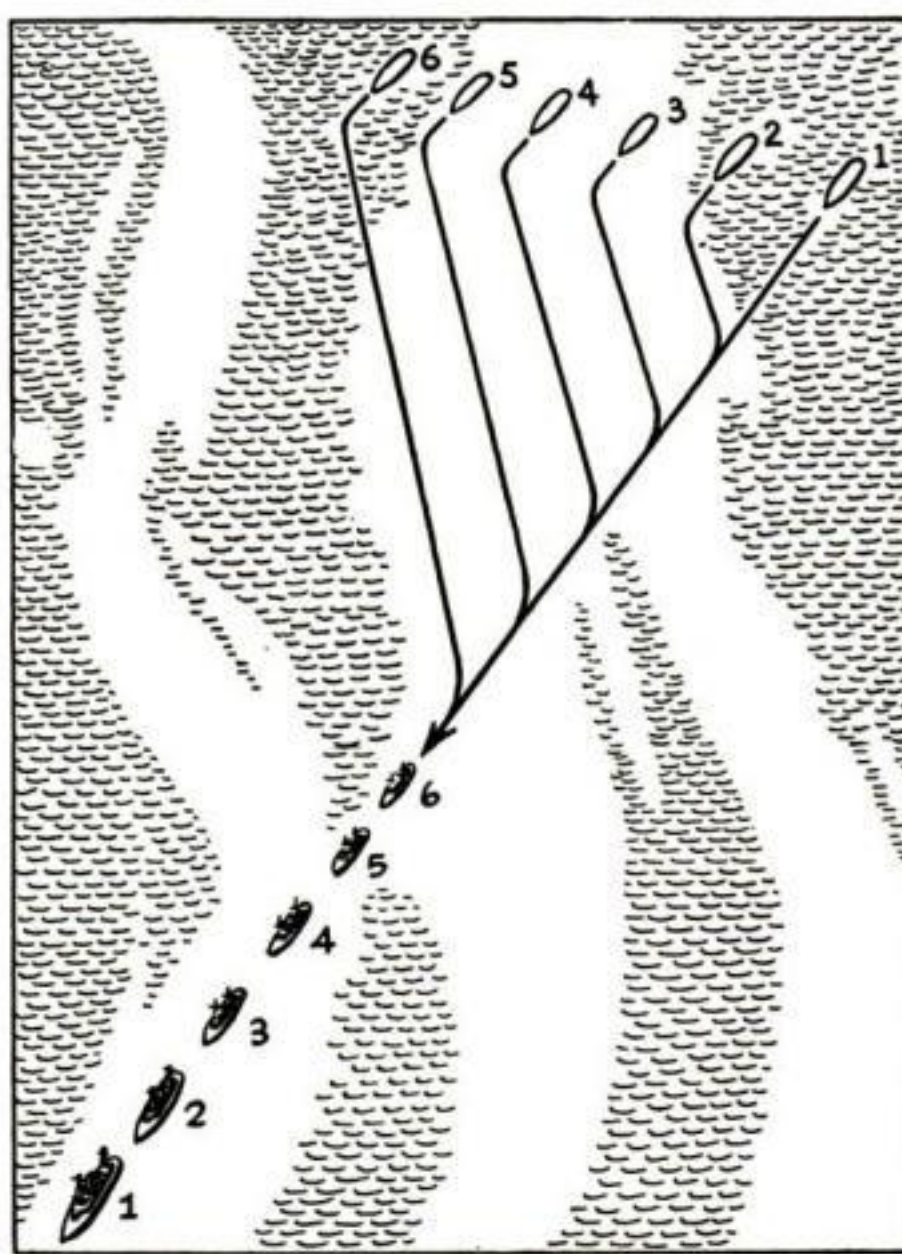
COLUMN OF DIVISIONS. Here the fleet is steaming in column of fours. It can easily swing into a single column, as shown on the next page



Seen from the sky through wisps of cloud, three columns of ships symbolize America's growing sea power



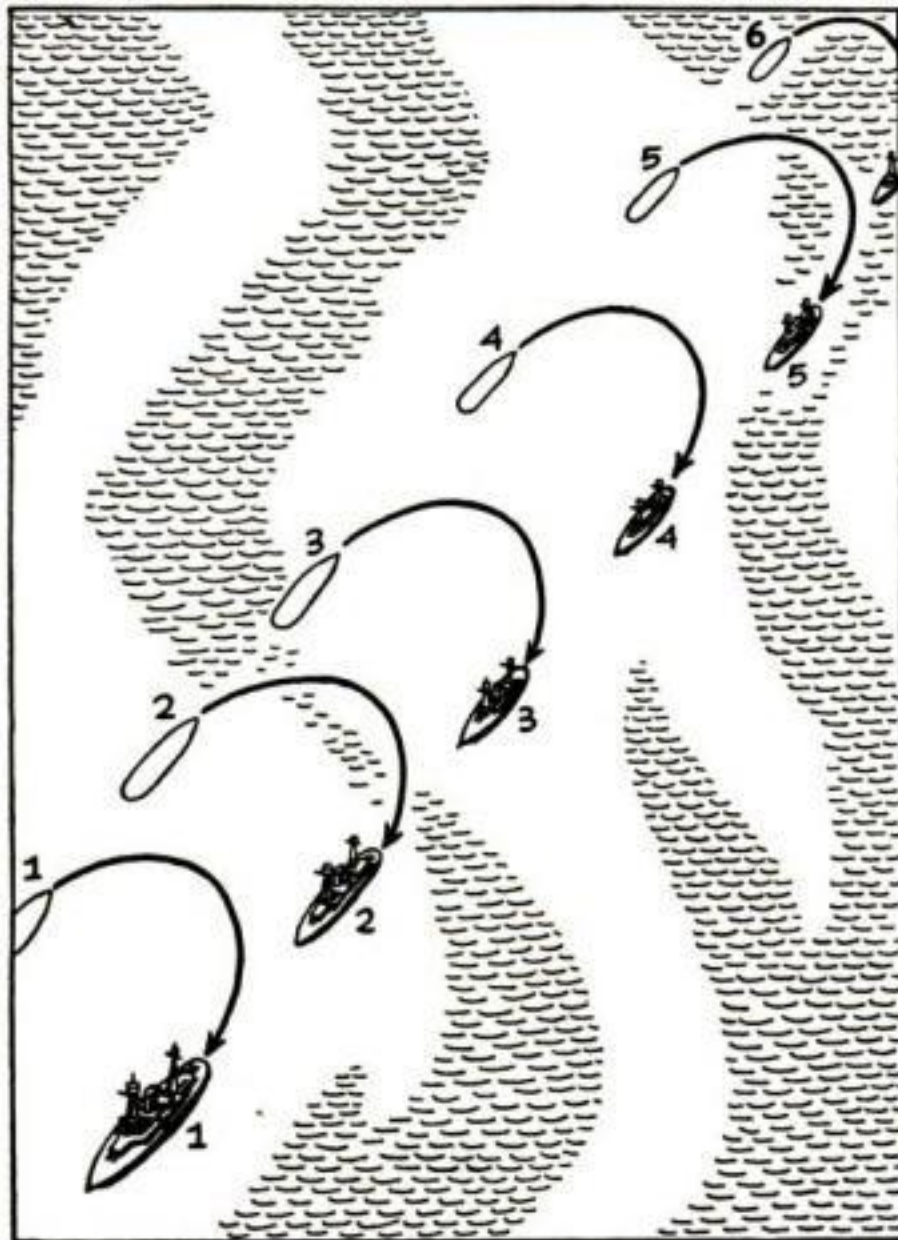
DEPLOYMENT FOR BATTLE. This maneuver, for bringing ships into single column, was used by the British at the Battle of Jutland in 1916



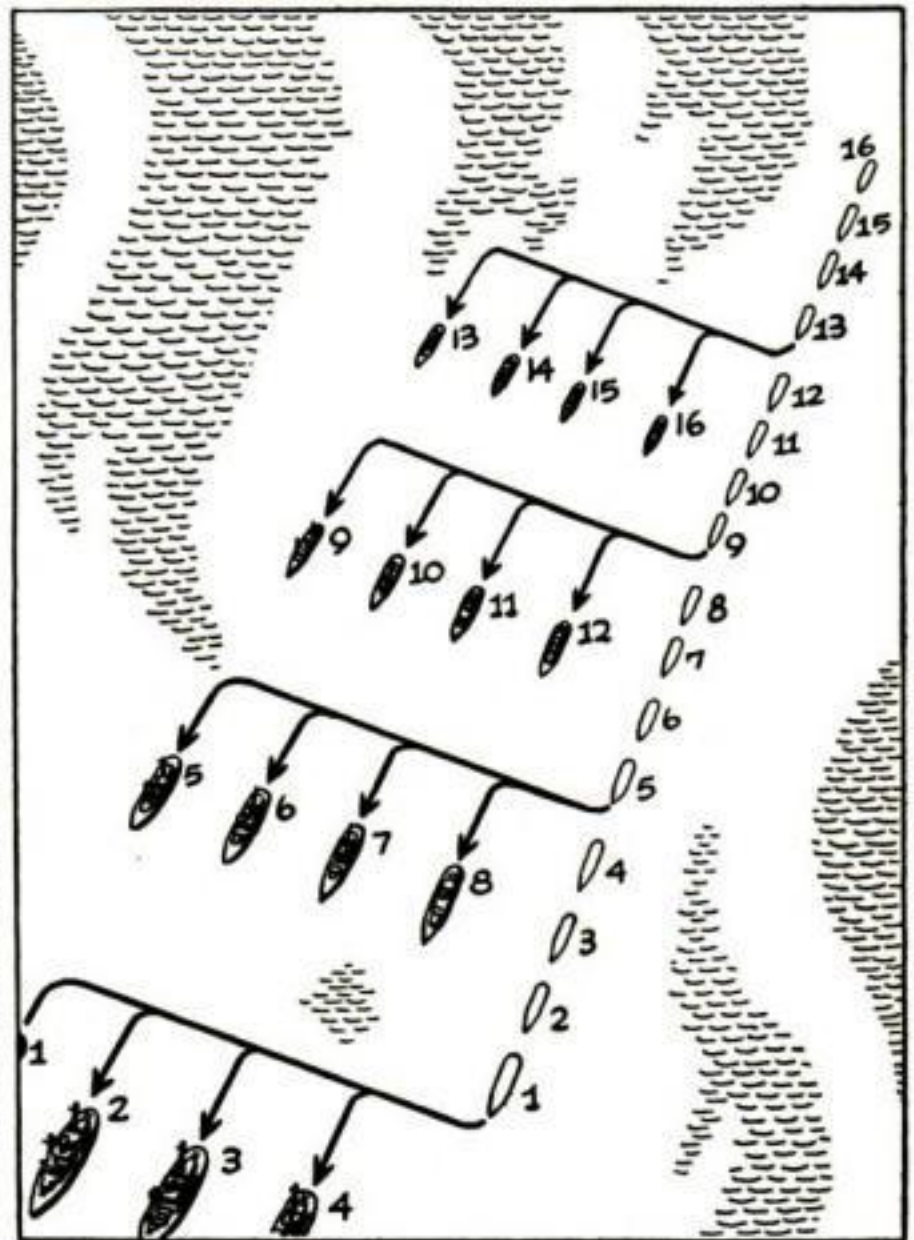
FROM LINE INTO COLUMN. With the precision of a football squad executing a signaled play, the battle wagons wheel into their places



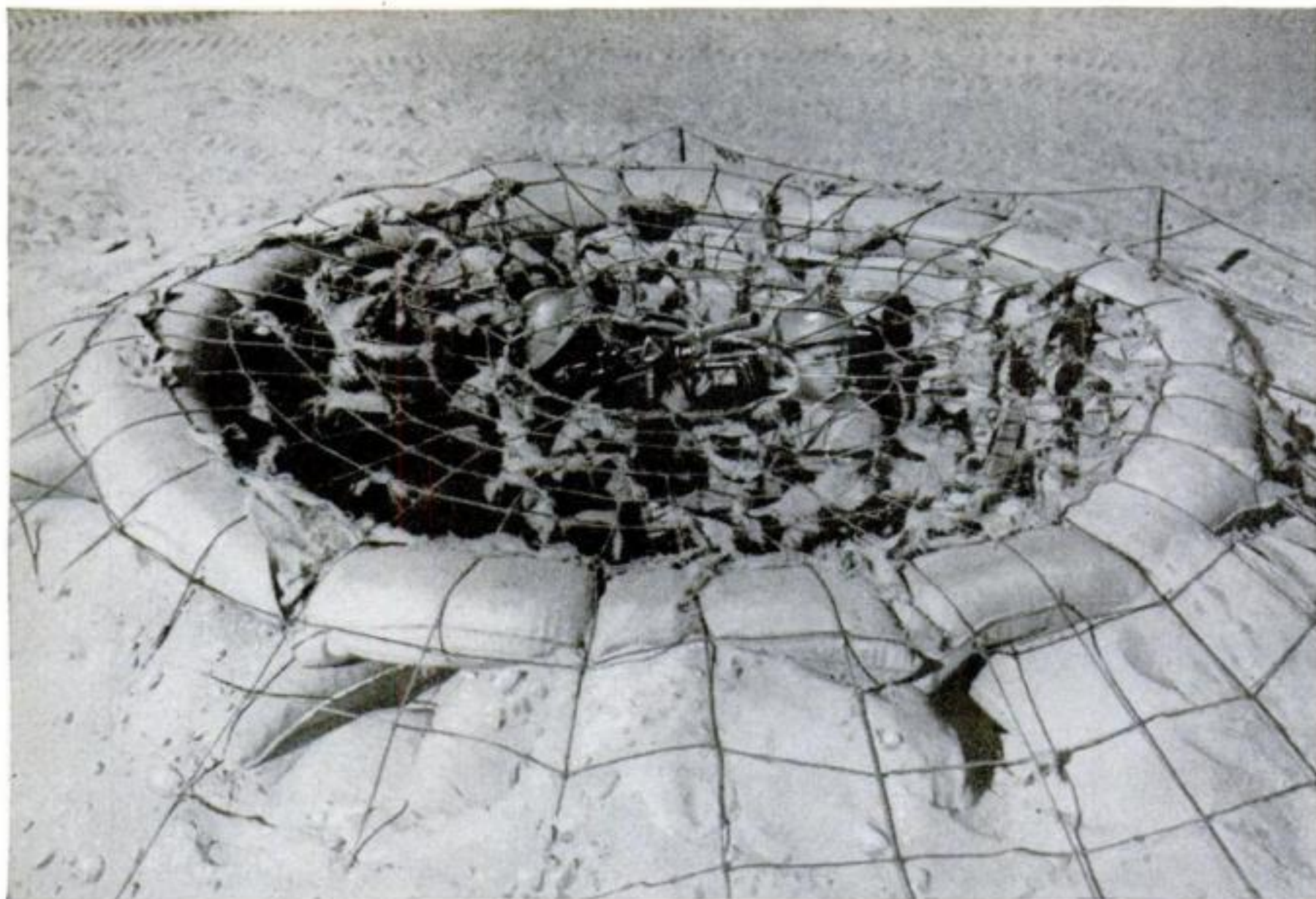
Fast cruisers slice the waves to place a protective screen along the flanks of the big battle wagons



SHIPS RIGHT ABOUT. This is a quick way to reverse the direction of a column of ships. Each vessel turns sharply and falls into place



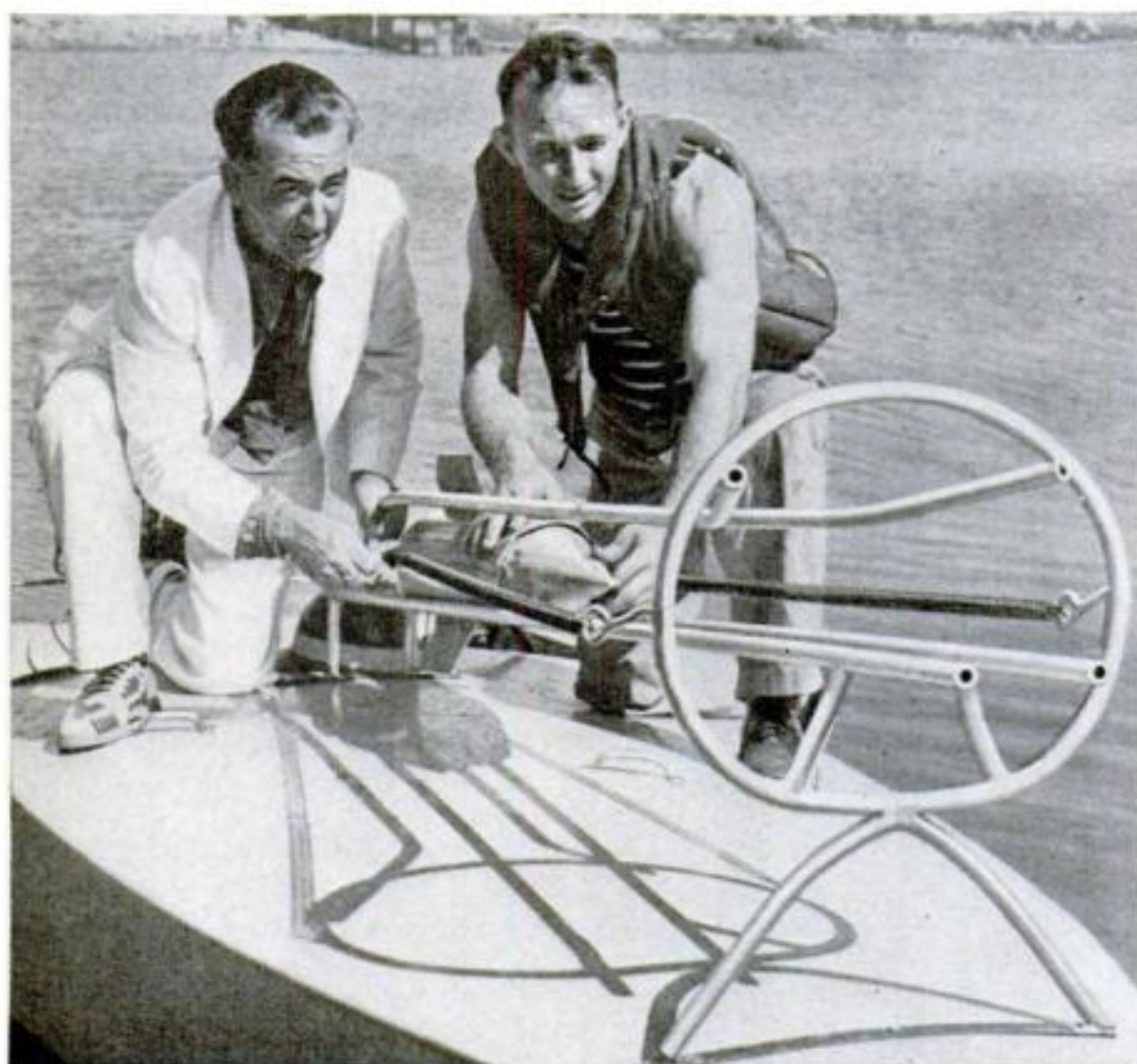
COLUMN, TO COLUMN OF DIVISIONS. To make this change of formation, the ships of each division swing out and form into a line abreast



Wire and Burlap Camouflage Desert Nest for Gunners

BLENDING into its desert background, the British Bren-gun post pictured above serves both as protection and as camouflage. Located somewhere in the Near East, the

circular post concealing the light, rapid-fire gun is made of piled sandbags covered with a spider web of cords on which shreds of burlap have been hung for concealment.



Fleets of these speedy "torpedo boats" could defend coastal waters

Tiny Torpedo Gun Arms Outboards for Coast Defense

TINY torpedoes can be launched from the decks of small outboard racing boats by means of a novel device tried out recently at Long Beach, Calif. Clamped to the boat deck, a metal framework supports a tubular-steel track, along which the torpedo is propelled and launched into the water by powerful coil springs. Hundreds of privately owned outboard boats, it has been suggested, could be equipped with the torpedo throwers to form a potent emergency defense fleet for the protection of coastal areas.



"Chess Game" Directs Air-Raid Defense

LIKE players at a giant chessboard, officers at the air-defense control center seen in the unusual photograph above are plotting the moves of hostile aircraft. Through headphones, "plotters" seated around the table map receive reports of unidentified planes and formations from field observa-

tion posts, and mark their positions and courses with counters. "Supervisors" wielding wooden rakes rearrange the counters to form a complete picture of the general situation. Observing the map from a platform in the rear, "tellers" telephone information to air-force commands.



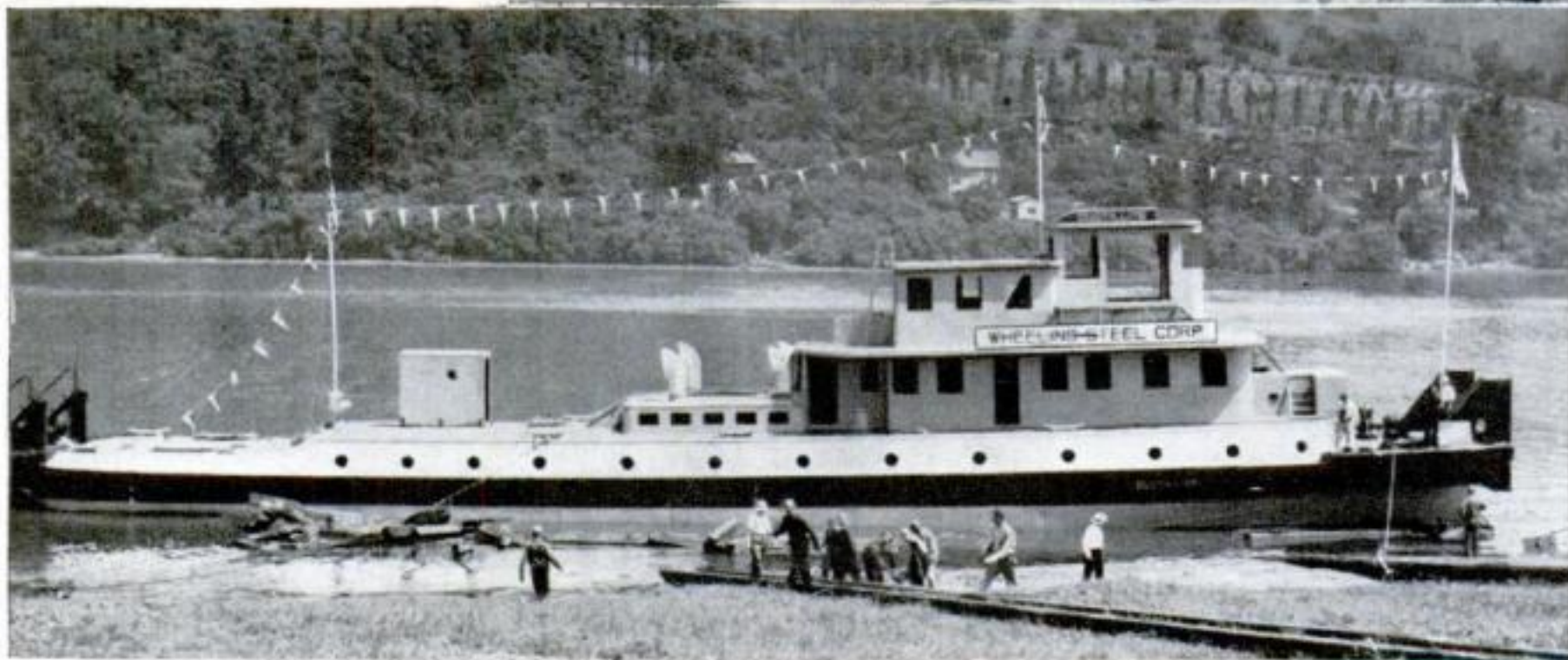
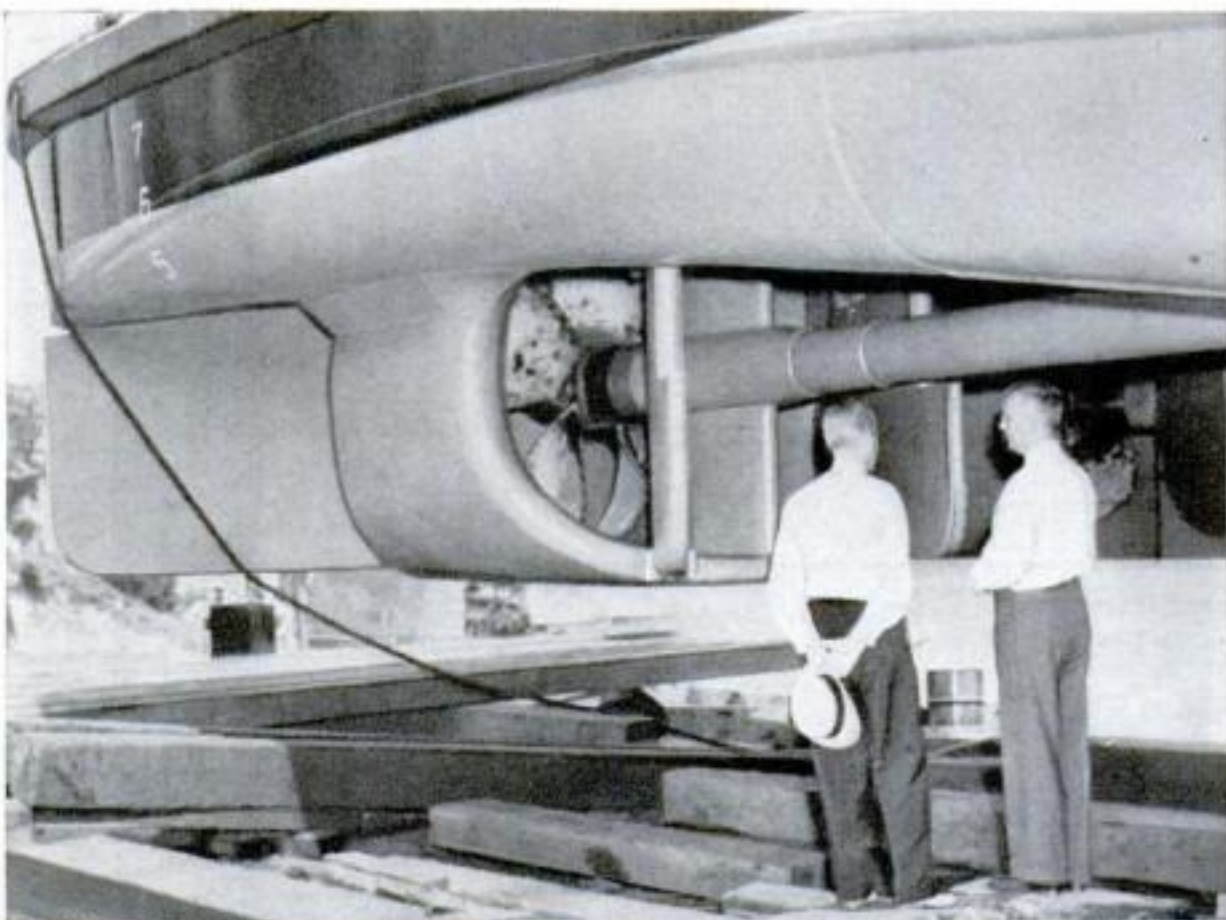
Tiny nose masks do not interfere with talking or eating

Vest-Pocket Respirator Guards Workers' Lungs

SMALL enough to be carried in a vest pocket, a one-ounce respirator protects industrial workers against dust with new convenience. The unbreakable, soft rubber device covers the nose alone, so that a wearer can talk, eat, smoke, and don glasses or goggles. While the user breathes naturally through his nose, an ingenious valve exhausts stale air and allows only filtered air to enter. Although the replaceable filter folds to wafer size, its effective area of nine square inches assures easy inhalation. Elastic ear loops hold the respirator.

Propeller Tunnels Boost Power of Ohio River Towboat

REVOLVING within tunnels of novel engineering design, twin propellers of the Wheeling Steel Corporation's new 135-foot towboat *Ductillite* propel it with heightened efficiency. Tests are said to have shown a thirty-percent boost above the normal push of the ship's two 760-horsepower Diesel engines. The ultramodern river craft will be used to tow coal barges from Harmarville, Pa., mines to near-by steel plants on the Ohio River. The novel vessel was launched sideways off the bank of the river.

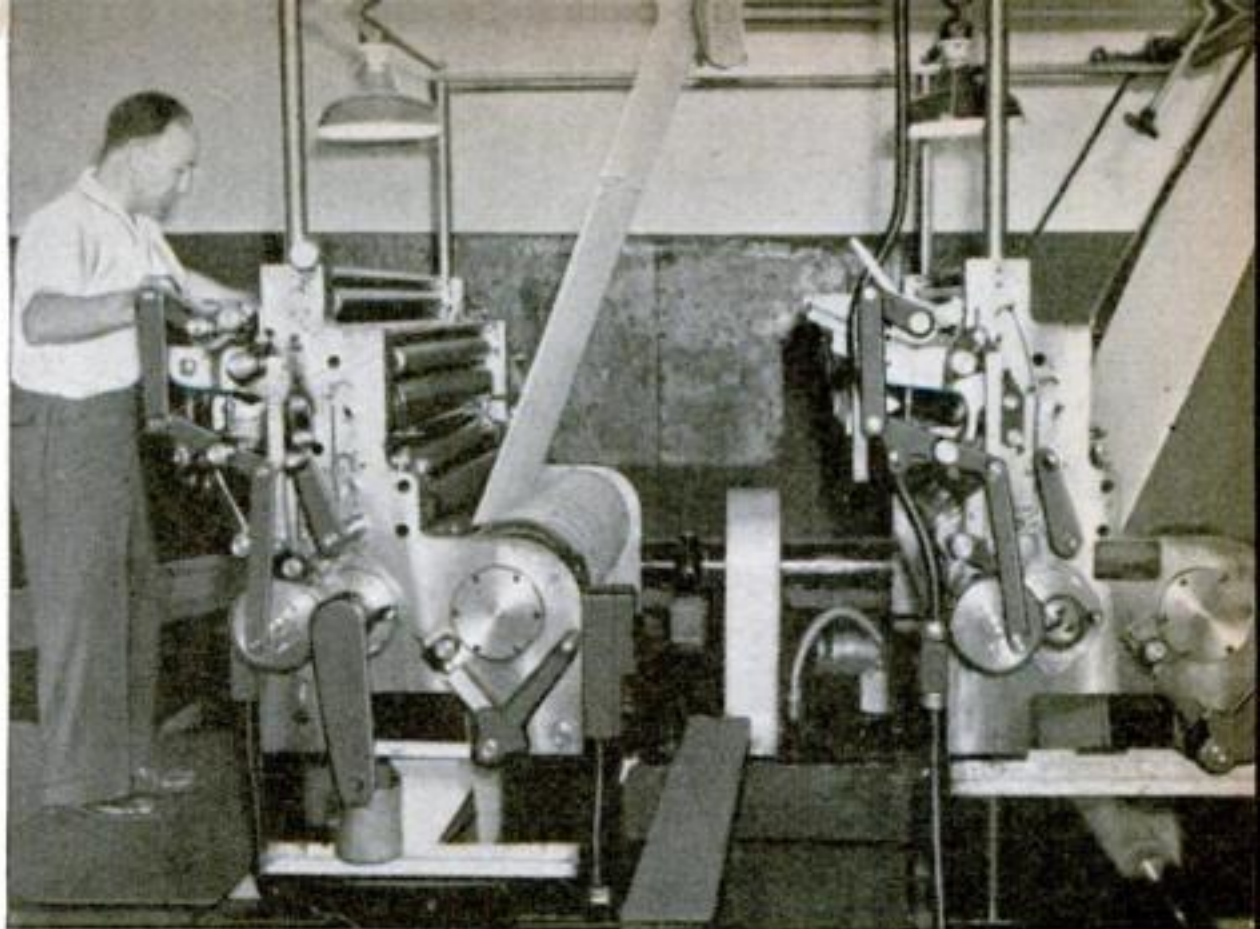


The ultramodern river towboat "Ductillite," as she appeared just after her recent launching. The upper view, taken when she was still on the ways, shows one of her twin propellers in its novel tunnel housing

Rubber Plates for Rotary Press Speed Up Printing and Cut Costs

PRINTING plates made from a specially compounded rubber are a new development that is expected to speed up the printing process and at the same time cut down its cost. With the new process, type is set by hand or machine and then transferred to a plastic matrix, or mat, by means of a hydraulic press. The rubber printing plate is then made from this mat. First, a sheet of the special rubber is placed in contact with the type-marked plastic mat. Next, a sheet of spring brass is placed over the sheet of rubber. Then the combination is placed in a powerful hydraulic press for a period of five minutes. The result is a rubber printing plate vulcanized securely to a spring-brass backing. This combination can then be bent around the cylinder of a specially designed rotary press for high-speed printing. According to the manufacturers, the rubber printing plates have many advantages: They print clearly at all times, even the finest type losing none of its definition. They wear longer than metal plates, having shown little wear after special tests when they were employed in making as many as 200,000 impressions. The rubber plates can be used to reproduce line drawings, or half tones if specially prepared. The plates cost about the same as electrotypes or offset plates, but they reduce printing costs due to the increased speed of rotary-press printing, and to a saving in the cost of making plates ready for the press. Because of their affinity to ink, the plates are said to print with less ink than metal plates. Duplicate rubber plates can be made from the plastic mat in only five minutes.

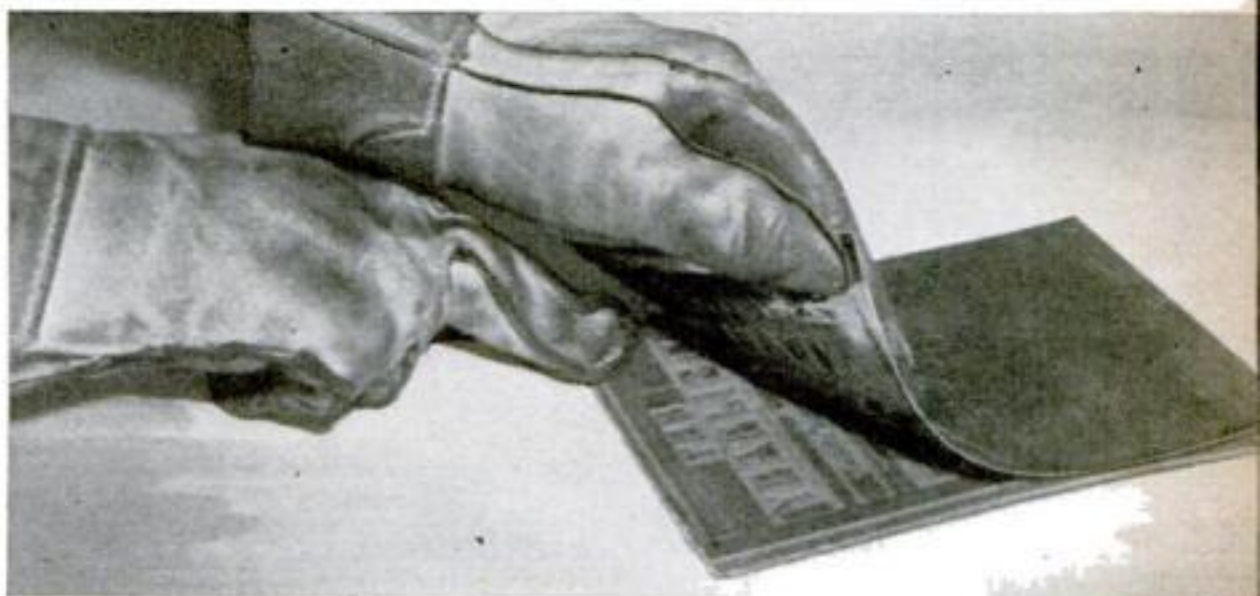
DECEMBER, 1940



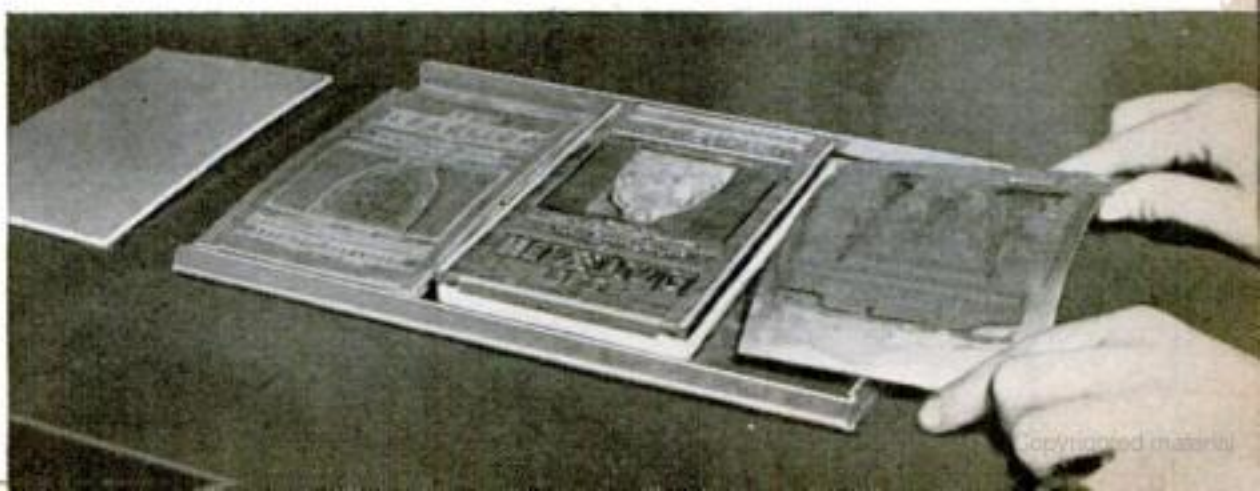
Outlasting metal plates, brass-backed rubber plates on the rollers of this special press will print over 200,000 impressions

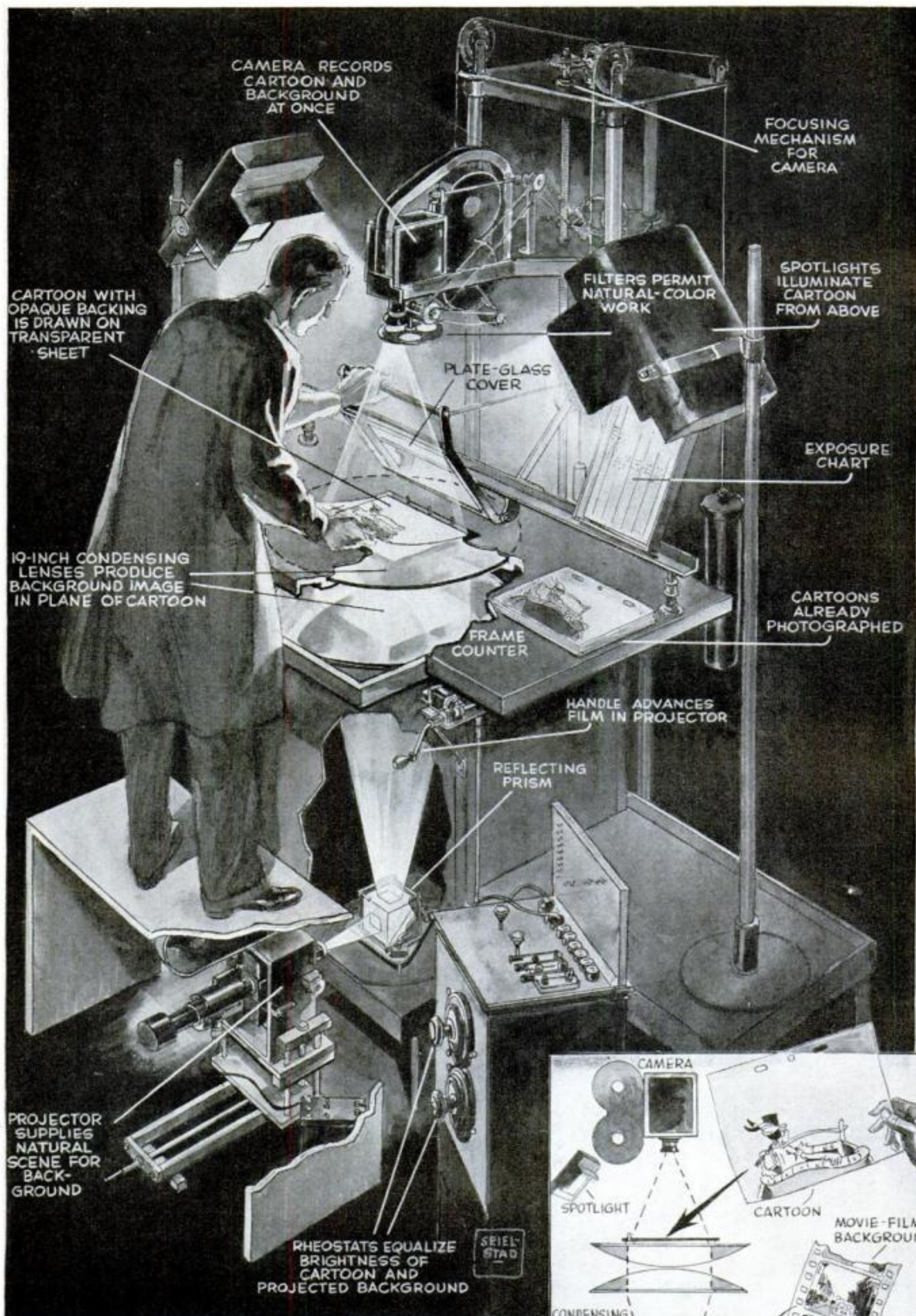


From a plastic mold made from conventional type, an impression is about to be taken on a rubber plate under pressure and heat

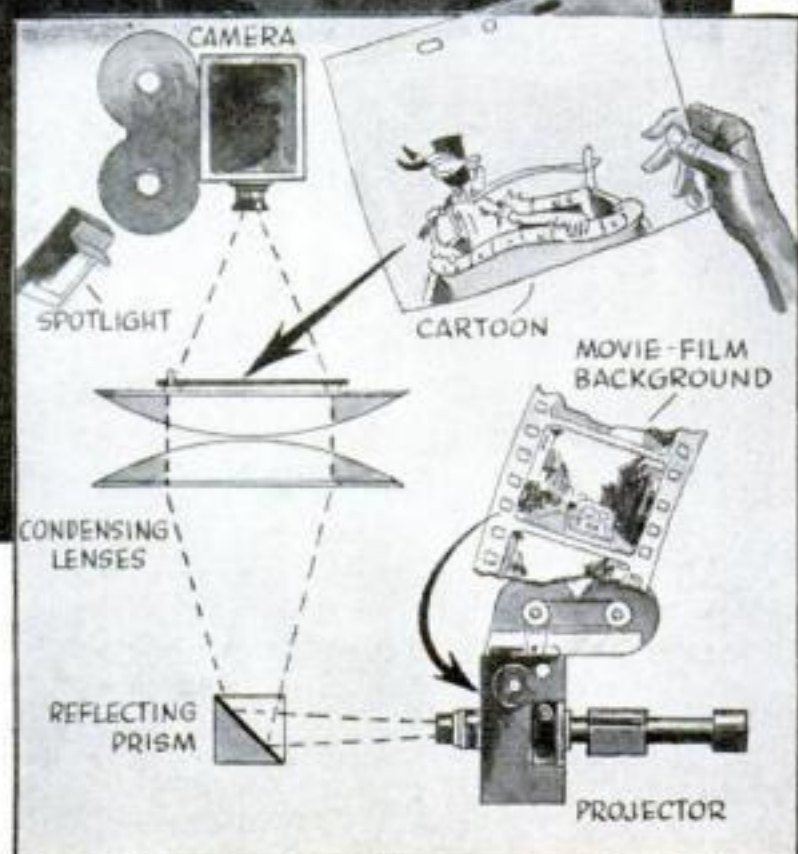


Removing the rubber plate with its spring-brass back from the plastic matrix. Its flexibility is evident, and it may be easily mounted on the rotary press. Below, the materials: Special plastic, plastic matrix, the original type, and the finished plate





WHERE CARTOON MEETS PHOTOGRAPH
This is how Paul Terry's ingenious camera puts together animated drawings and natural photographs. The optical arrangement which makes this novel effect possible is illustrated at right



New Cartoon Camera

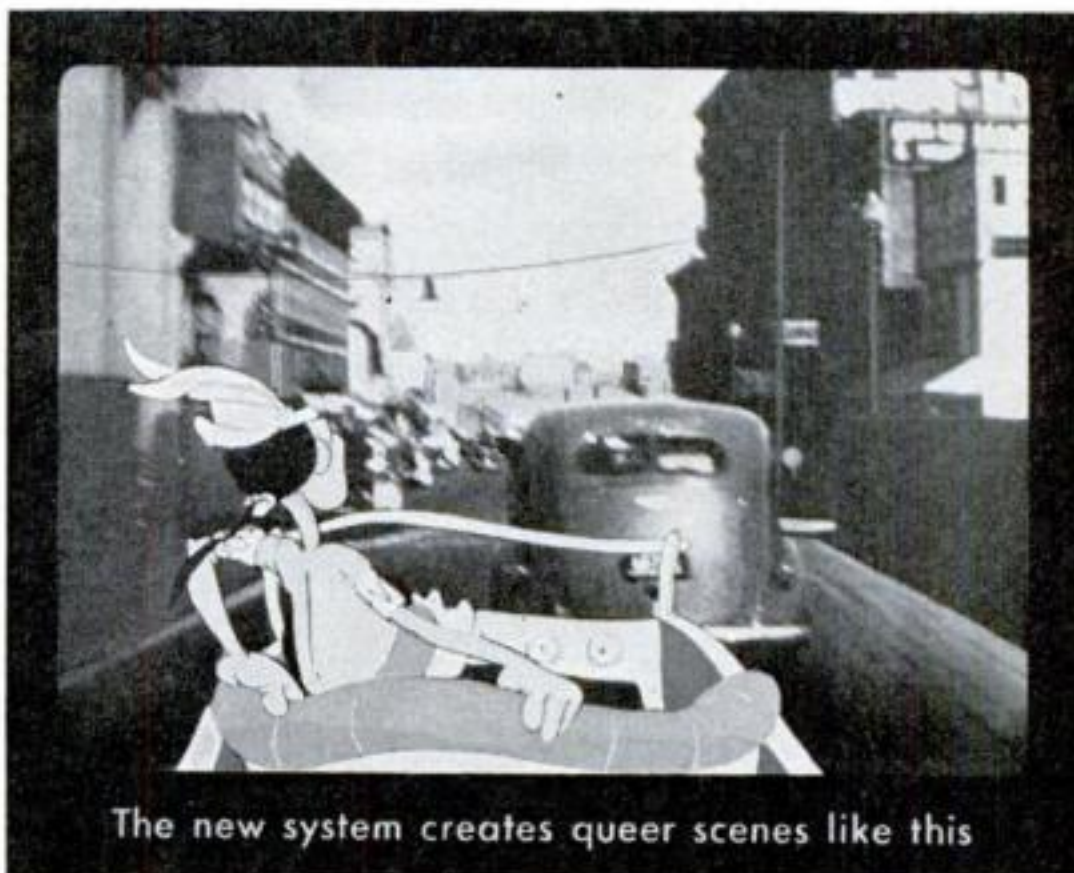
COMBINES DRAWINGS AND PHOTOGRAPHS

A REAL car with a flesh-and-blood driver rolls sedately along a busy city street. Careening behind it, a caricature of an Indian in a speeding jallopy performs antics that would whiten the hair of a traffic cop. Trick photography produces animated movie cartoons of this novel sort, combining hand-drawn characters with natural backgrounds, in the studio of Paul Terry at New Rochelle, N. Y.

In making the 6,000 separate cartoons that go into a typical 500-foot animated film, the artist uses a special procedure. Each figure or object is drawn on top of an opaque silhouette, of black or white pigment, applied to a transparent sheet of celluloid. Hold it up against the light, and you will see only the black outline of a figure; by reflected light, its details appear. So each cartoon receives the illumination of a pair of spotlights, from above, while a stop-motion camera photographs it. Meanwhile the opaque cartoon effectively blocks out the unwanted part of a real movie scene, which is projected from below through the transparent part of the celluloid. The rest of the background automatically is photographed with the cartoon, giving a composite picture. For each succeeding frame, the same procedure is used, after cartoons and background scenes have been shifted.

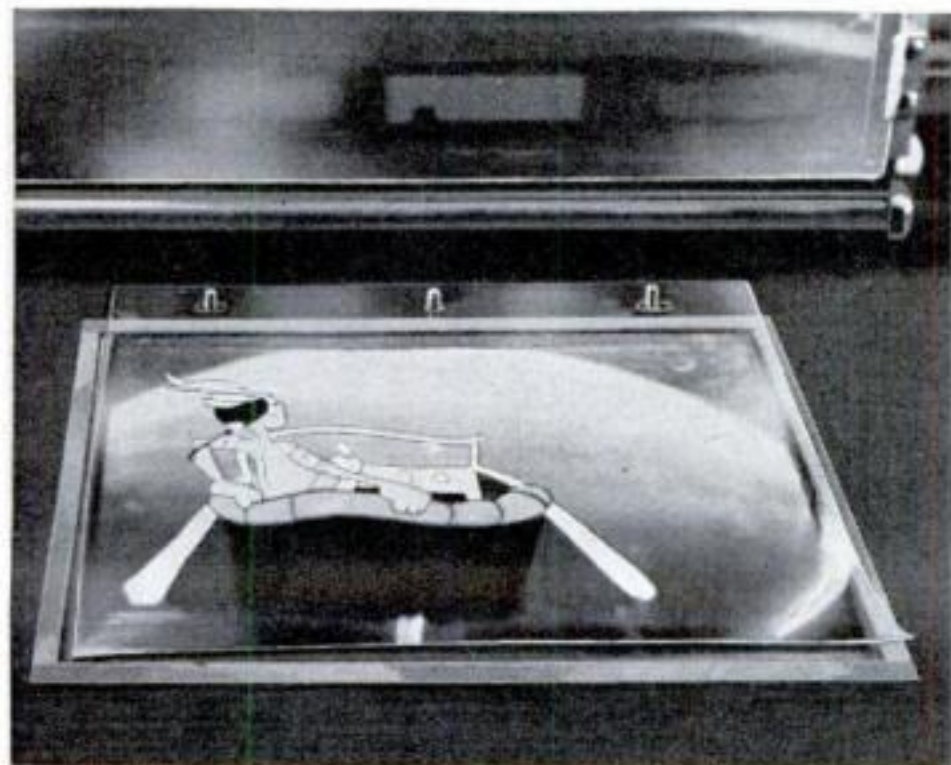
Simple as the scheme may appear in

Lighted from above, the drawing is picked up by the camera, and masks the background



principle, its practical realization required an optical set-up so original that it has been awarded a patent. To match the size of an artist's drawing, background pictures on standard movie film had to be greatly enlarged. Through the reflecting prism illustrated—which simply serves, like a mirror, as a space-saving device—a projector could have thrown the film image upon a screen of ground glass. By scattering the light, however, the screen would make the system relatively inefficient and slow. Therefore Terry substituted a huge pair of nineteen-inch condensing lenses, the most costly part of the whole apparatus, for the ground glass. They form a brilliant "invisible" image which can be seen only by the camera's lens, or by placing the eye in exactly the same position, unless a translucent screen is temporarily inserted for focusing. Since this background image can be adjusted to fall exactly at the level of the cartoon, the camera easily brings both to a sharp focus. Light-regulating controls adjust the illumination from spotlights and projector until they balance, and all is ready for picture making.

Rapid and economical, the new process will make animated cartoons either in black and white or in full color. For the latter purpose, a set of color-separating filters occupies a rotating mount over the lens. Every full-color drawing, with its corresponding background of color film, is then photographed through each filter in turn.



Hollywood Moves



COMPLETING in eight days what nature requires two generations to accomplish, nurserymen and movie-studio workers recently transplanted a forest of pine trees from southern California mountains onto the Paramount studio lot in Hollywood, 100 miles away. Men working in twenty-four-hour shifts cut the trees, and in 100 truck loads dispatched them down a winding mountain road from Arrowhead to the movie capital. Larger than any trees ever to ride the highways, they measured up to ninety-seven feet tall.

H. E. Buettner, foreman for a nursery concern, faced the unusually difficult problem of lowering the trees 600 feet down a steep mountainside and delivering them on the set, without breaking their branches,

Left, one of the 350 trees hauled from 100 miles away is set up by a boom truck on a Hollywood movie lot



Building a hill, shown in background of scene at right

a Forest

for full-color scenes in "Northwest Mounted Police." He succeeded by skidding them to the waiting trucks on an elevated cableway, then blocking them up on the truck floor over an inverted "V" made of timbers. Although some trees overhung nearly fifty feet, few branches were lost.

Carpenters erected the movie forest by placing each tree in a huge wooden "Christmas-tree stand." Some of the trees stood on a synthetic hill made of wood and plaster. Others were "planted" on top of sound stages and a water tower, both to hide the structures and to give the illusion of distance. The set covered nearly six acres. Hundreds of tons of earth were moved to create the uneven forest-like terrain. Forest rangers were stationed to guard against fire.

Among obstacles to moving the trees was this steep mountain highway down which they were successfully brought





Playing the ancient Chinese game of "nim" with the machine

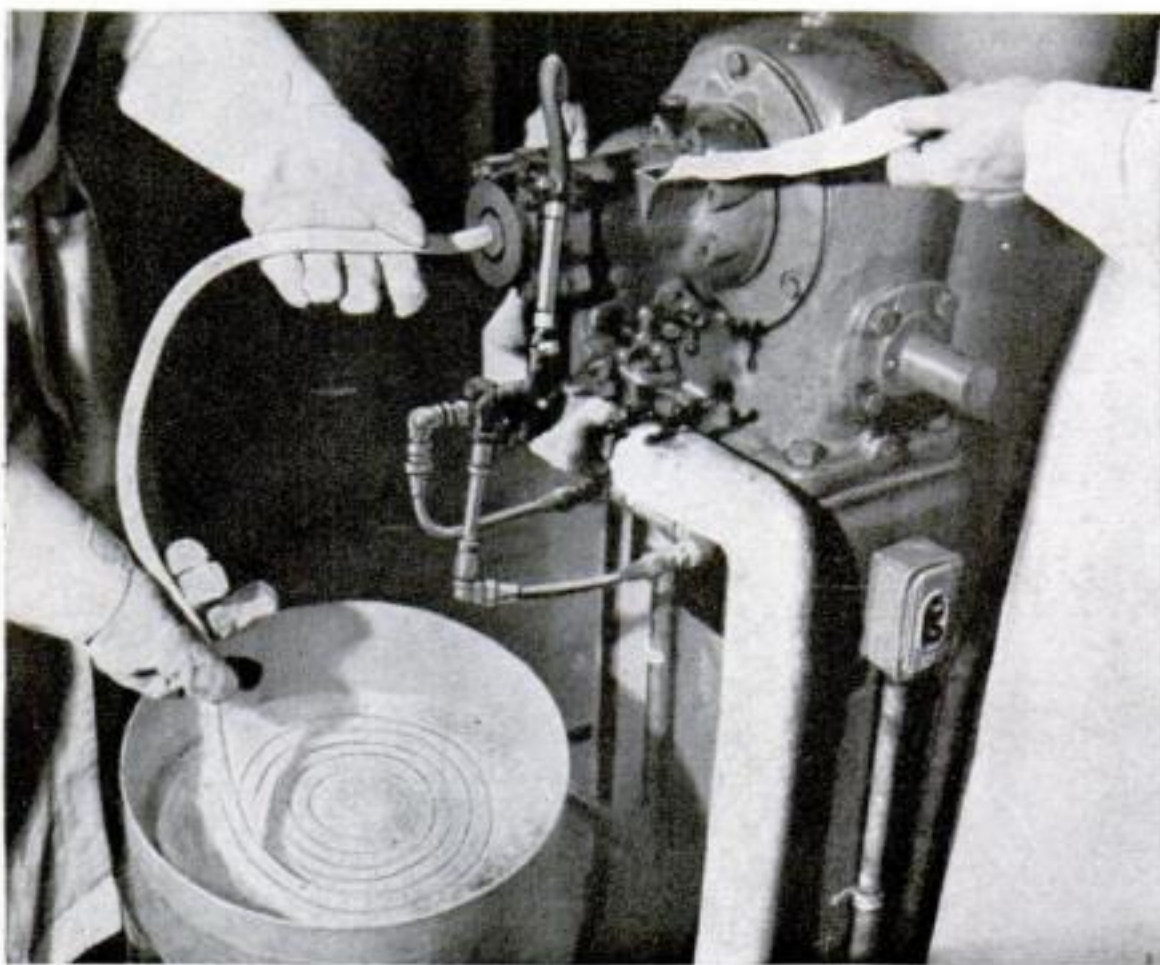
Playful Machine Is Hard To Beat at Own Game

A PLAYFUL, one-ton electric brain, exhibited by Westinghouse engineers, challenges all comers to the ancient Chinese game of "nim." Red, blue, yellow, and green lamps, extinguished by pushing buttons, replace counters drawn from stacks in the original game. A player first turns out as many lamps in one row as he chooses. Then the machine, operated by 116 relays, takes its turn. This goes on until the machine or its opponent turns out the last lamp, winning the game. Since one wrong move means certain defeat, a player has small likelihood of beating the robot by chance. But he is sure to win if he can think fast and accurately in what mathematicians call "powers of two of the binary system of numbers." The baffled automaton then presents him with a pocket token.

New Synthetic Rubber Is Made Directly from Petroleum

MADE directly from petroleum, a new kind of synthetic rubber helps relieve U. S. dependence on foreign sources for a vital raw material. Named butyl rubber, the product, shown below in its peculiarly shaped raw state, has been placed in semicommercial production by the Standard Oil Company of New Jersey, for auto tires and other purposes. From this and different types of synthetic rubber, including Ameripol, Neoprene, Koroseal,

Pliofilm, Thiokol, and American buna, defense experts now can choose a variety with characteristics best suited for the particular use to which it will be put.



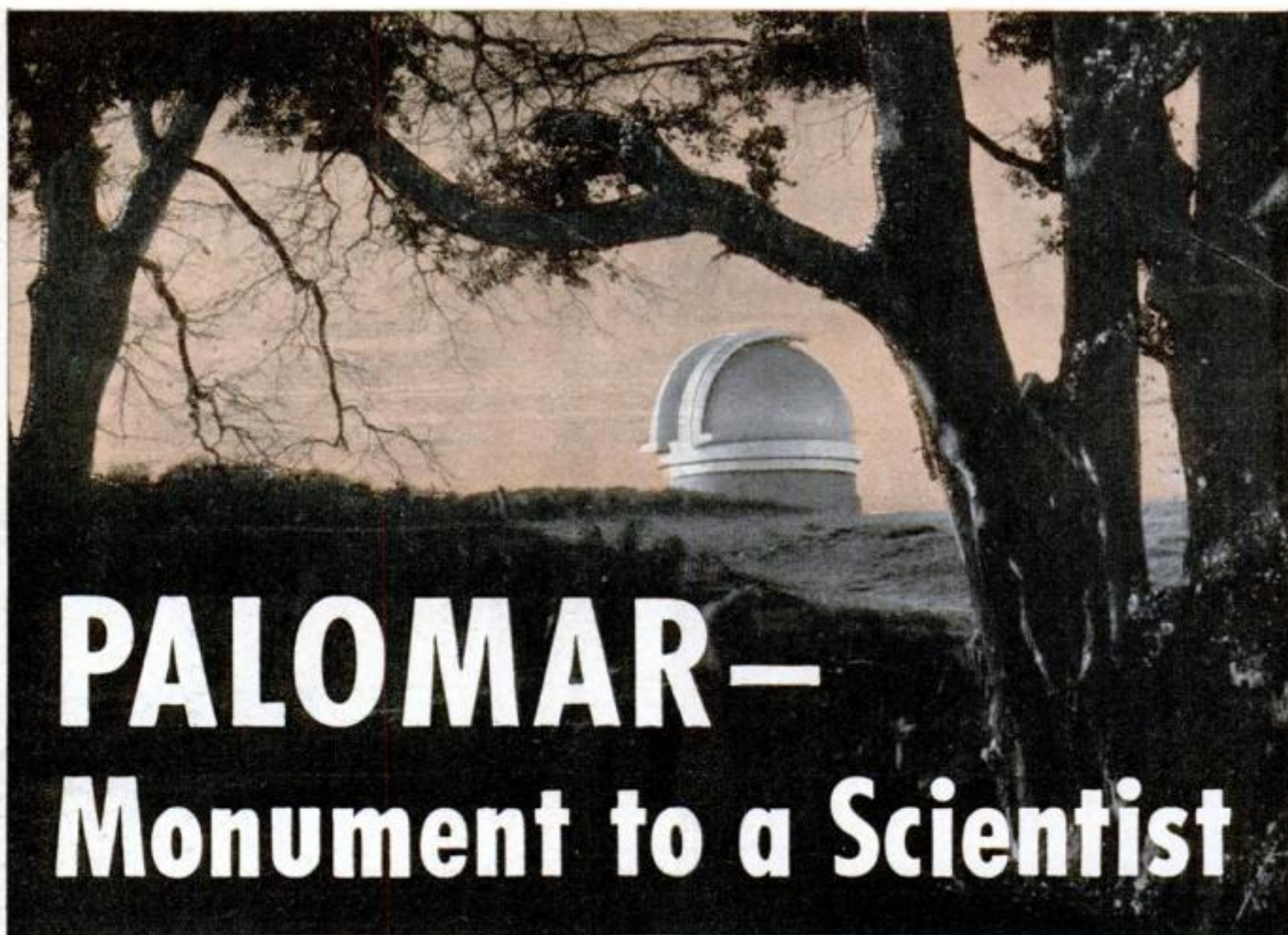
Looking like heads of cauliflower, the raw "butyl" synthetic rubber is shown at left. Above, a machine converts it into tubing



Giant Atom Gun Gets Final Check-Up

IF YOU think this man is putting an enormous stack of pies into an oven, you're mistaken. Actually he's searching for any possible leaks in one of the world's biggest vacuum tubes. At its top, by means of a glow discharge, a new University of Pennsylvania atom smasher liberates electrified

particles of heavy hydrogen or helium. High-voltage electrodes hurl these "bullets" downward through the cylinder. When they hit the material chosen for the target, at the bottom, they are traveling at speeds up to 18,000 miles a second! A near-by tunnel offers observers a refuge from deadly rays.



PALOMAR— Monument to a Scientist

From the Book, "The Glass Giant of Palomar"

By **DAVID O. WOODBURY**

SEVENTY years ago, the great romancer, Jules Verne, told of a gigantic reflecting telescope which would follow the flight of a projectile fired from the earth to the moon. Twelve years ago, Dr. George Ellery Hale, founder of Mt. Wilson Observatory, in California, improved upon Verne's prophecy in the design of a 200-inch telescope. Today, a mile above the Pacific, on the top of Palomar Mountain, this glass giant is nearing completion. Soon its great aluminum-coated mirror will be turned upon the heavens, dragging billions of now-invisible stars out of obscurity. It began as one man's dream. It will stand as a monument to that dream and that man.

THE story of the glass giant of Palomar goes back to the year 1881. George Hale, the thirteen-year-old son of a well-to-do manufacturer of elevators, in Chicago, Ill., had decided to build a telescope. His father gave him the money willingly and he hurried off to buy a small lens which he mounted in a homemade tube. It was a pretty crude affair, but it decided his career. He would be an astronomer.

A little later, he heard of a telescope with a four-inch lens that was for sale, second-hand. He explained to his father that he wanted to study the spectrum of the sun. The elder Hale again put up the money and George mounted the instrument on the roof of the family residence.

In his freshman year at the Massachusetts Institute of Technology, young Hale made arrangements with Director E. C. Pickering, of the Harvard Observatory, to take care of some of the instruments and use them when the astronomers did not want them. There, he got his first actual training in the observation of the heavens. Almost at once, his vigorous young mind struck off into pioneering territory. By the time he was a junior, he had invented an important new astronomical instrument, the spectroheliograph, which photographs the sun by the light of one chemical element at a time. It was not until two years later, after he had graduated and was installed in a back-yard observatory of his own, which his father had built for him in Kenwood, a suburb of Chicago, that he was able to make his innovation work satisfactorily. With the aid of a nineteen-year-old photographer named Ferdinand Ellerman, Hale was able to photograph for the first time in history the towering flames of the prominences shooting 500,000 miles up from the solar rim.



DR. GEORGE ELLERY HALE, father of the three greatest astronomical observatories in the world—Yerkes, Mt. Wilson, and Palomar. At the time of his death in 1938, his last and greatest achievement, the 200-inch telescope at Mount Palomar, in California, was well on the way to completion.

In the same year, the young astronomer was married. His wedding trip carried him to the Lick Observatory, in California. Soon afterward, he visited Europe and found the fame of his spectroheliograph had preceded him. At twenty-three, he was already considered an authority on the sun. After a year abroad, spent principally studying in Berlin under Helmholtz, Planck, and other famous physicists, he returned to Chicago.

Although he was then only twenty-four, his friend, President Harper of the newly founded University of Chicago, made him associate professor of astrophysics. It was not long before George Hale and Harper were deep in plans for an observatory big enough and complete enough to carry the astronomer's researches to their logical conclusion. The little twelve-inch telescope in his Kenwood observatory was satisfactory only for preliminary studies. He had been deeply impressed with the thirty-six-inch instrument at Lick. It was then the world's largest and Hale had come home with an ambition to own one like it. Once provided with a *large* telescope, he could indeed lead the world to something new.

ABOUT this time, Hale attended a scientific meeting in Rochester, N. Y. Purely by chance, he overheard somebody talking to the great lens maker, Alvan G. Clark. Clark was in a quandary. The University of Southern California was sponsoring a scheme for outdoing Lick and building a telescope even larger than the thirty-six-inch instrument. After two huge forty-inch disks were in Clark's workshop ready for grinding, word came from California that an expected gift of money to pay for the lens was not forthcoming. The University couldn't even pay for the glass. Clark was out of pocket \$20,000 and, as there was no one else in America who could possibly afford such a telescope, the great disks were

likely to be left on his hands, orphans.

Hale rushed back to Harper with the news. Ready to their very hands, he said, were glass disks large enough to make the most powerful telescope in the world. But where was the money to come from?

"What are you going to do?" Harper asked.

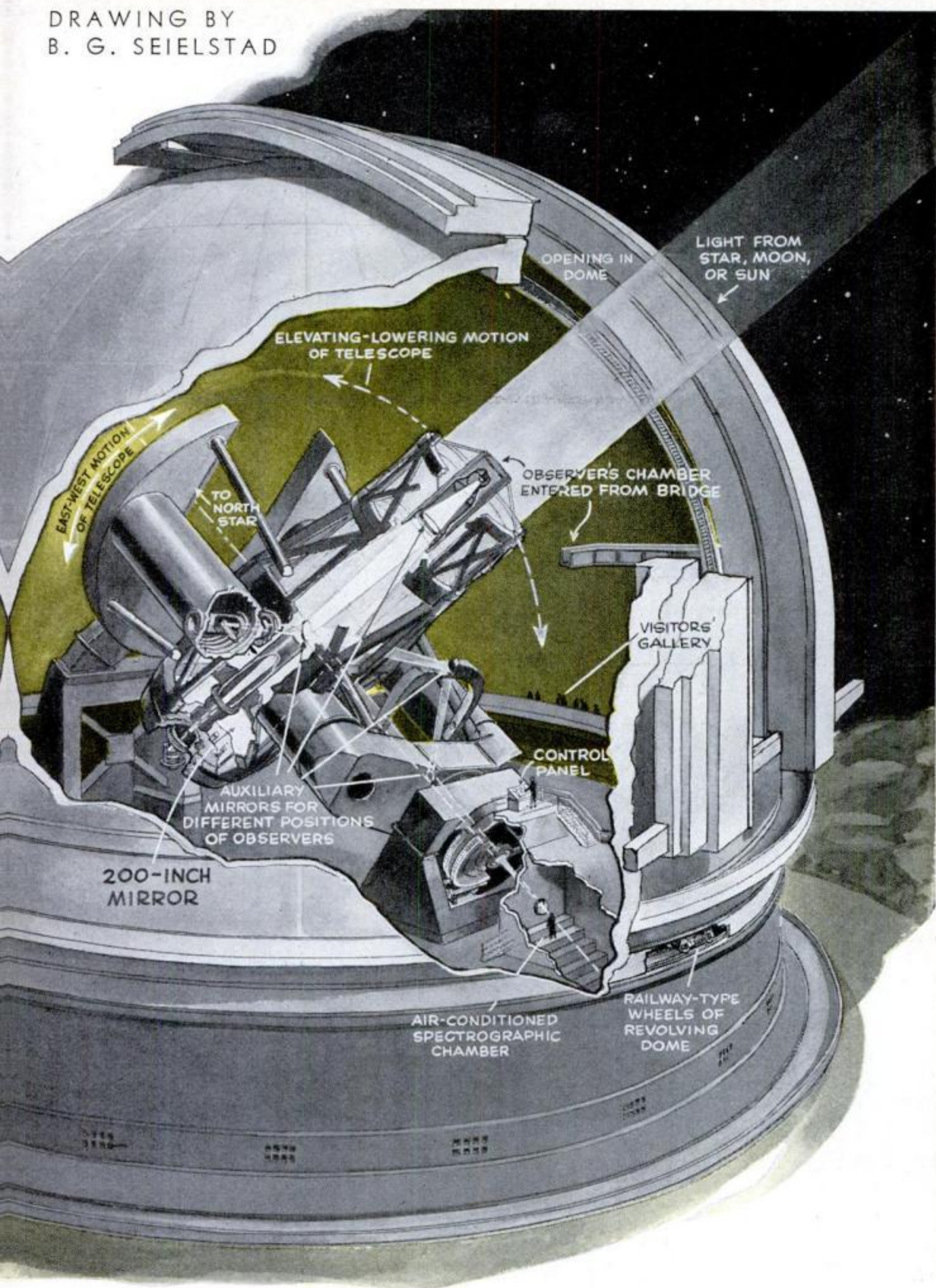
"See Charles T. Yerkes," said Hale.

Yerkes was one of Chicago's most wealthy men—and most influential. Hale laid his plans carefully. He got himself invited to a dinner that Yerkes was to attend and contrived to sit next to him. Then he began talking astronomy. Yerkes soon became fascinated. This young man with his vivid interest in the stars was worth investigating. Before he knew it, he had admitted to Hale that he had dreamed since boyhood of building the biggest of all telescopes. Hale left the dinner with Yerkes' check for \$20,000 in his pocket to buy the Clark glasses, and his promise of enough more money to make them into a forty-inch lens. In the end, the financier contributed a total of \$349,000 to complete the famous Yerkes Observatory on the shore of Lake Geneva, in Wisconsin.

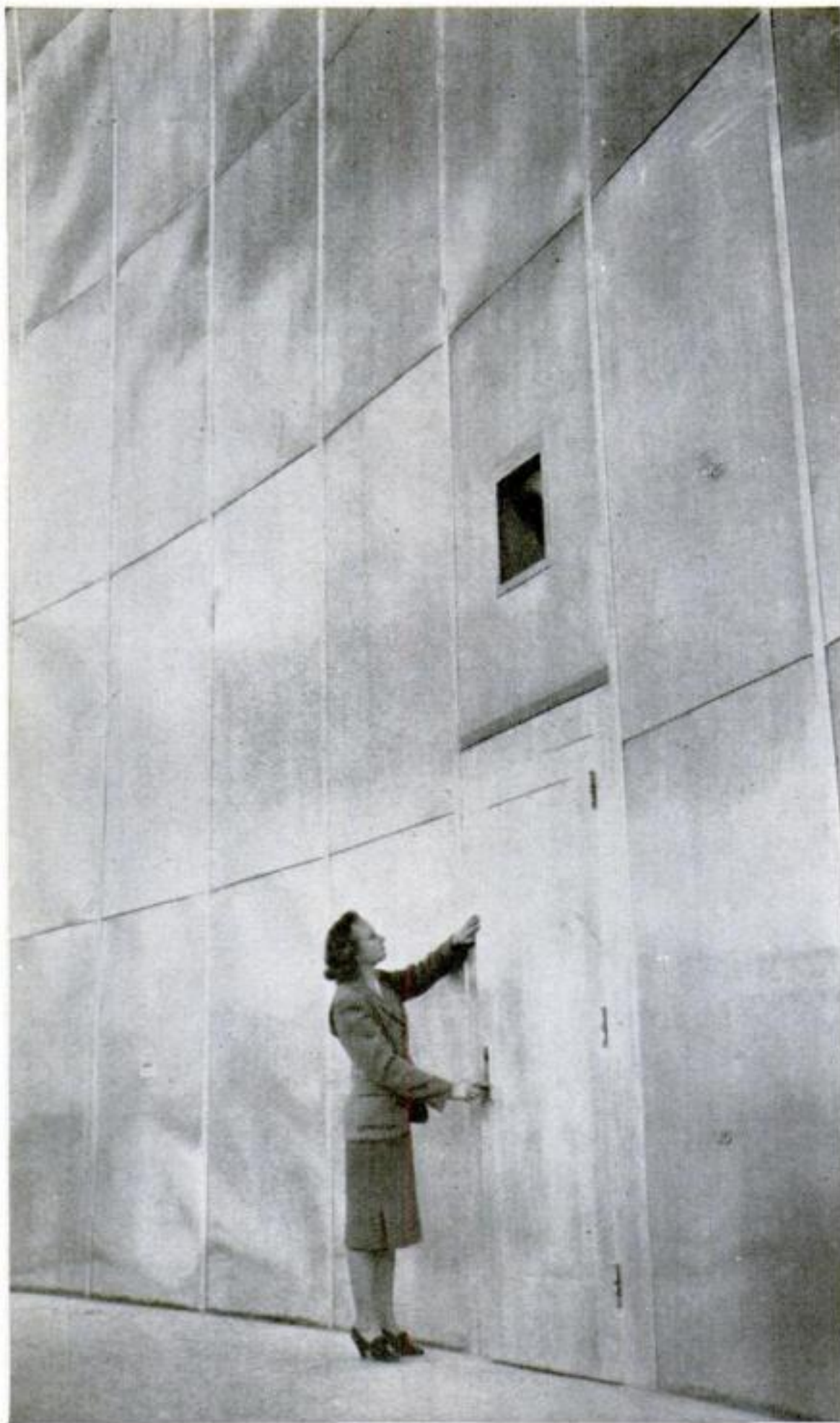
It was his father, who had provided sympathy and help so many times, that contributed another stride to his advance. Even with the Yerkes Observatory, Hale realized that he needed an instru-



DRAWING BY
B. G. SEIELSTAD



THE GLASS GIANT OF PALOMAR. How the 200-inch eye will be mounted under its huge shell, taller than a fifteen-story building, atop a mountain a mile above the sea



Aluminum walls and doors are part of the system that controls the temperature under the big dome

ment more powerful than the forty-inch telescope to make the study of stellar evolution effective. His father saw this. Quietly, he wrote to a famous French glass maker and ordered the largest disk he could turn out. When it arrived, a great slab of clear green glass eight inches thick and sixty inches in diameter, he presented it to his son.

That slab of glass became, later on, an important aid at the famous observatory at Mt. Wilson. It was the first of the modern reflecting giants which have culminated in the 200-inch instrument at Palomar. The sixty-inch telescope went into service in 1908. Already, Hale was busy with plans for

a 100-inch giant. A campaign to have the Carnegie Institute, of Washington, D. C., establish a solar observatory on Mt. Wilson had succeeded and an old admirer of Hale's, John D. Hooker, had promised the money for a new giant of the sky, a 100-inch reflecting telescope.

It was 1918, and the World War was drawing to a close, when this huge astronomical eye made its debut. It has remained for twenty years science's mightiest weapon in the attack upon the stars. Men that Hale had trained—men at Mt. Wilson, at Yerkes, even at his own private observatory at Kenwood—had carried on the details of solar study, year after year.

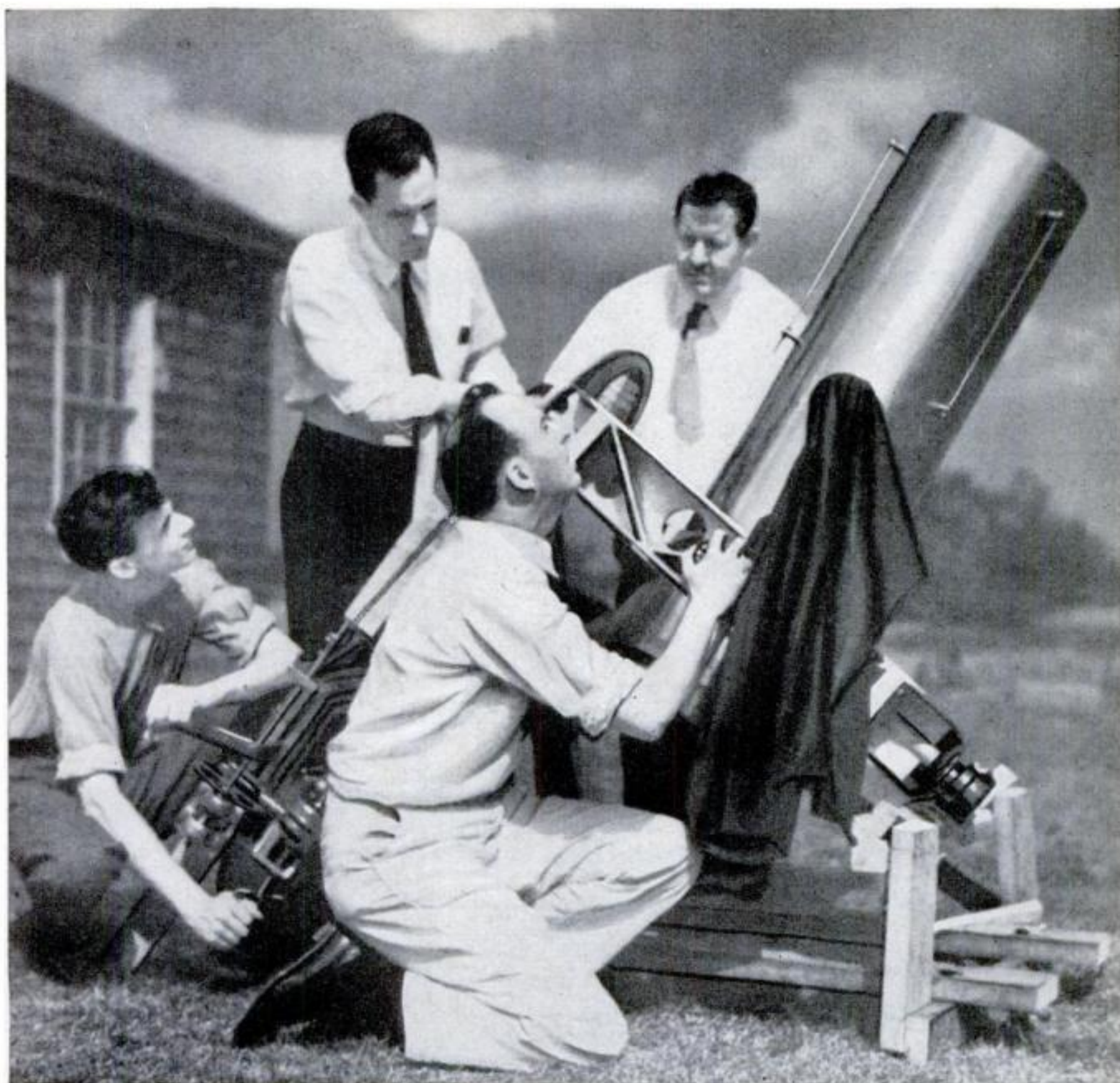
When the boundaries of the universe—as far as the 100-inch telescope would reveal them—had been explored, Hale, now a man nearing sixty, came to the conclusion that there was only one course to pursue. More light! A larger telescope still! Thus it was that his long dream reached its climax in plans for the glass giant of Palomar.

How the Rockefeller General Education Board, in New York City, allotted the sum of \$6,000,000 for the Palomar project; how the great glass disk, in the face of staggering difficulties, was cast at Corning, N. Y.; how it was transported on special trains, nursed through tunnels and down steep grades while crack flyers stood on the sidings to let it pass; how the

mountaintop observatory took shape to receive it—all this is recent history.

When Hale passed away on February 21, 1938, he left behind three of the greatest observatories in the world—Yerkes, Mt. Wilson, and Palomar—as his monuments.

It is curiously fitting that the last and greatest of these monuments, the observatory on Mt. Palomar, was still incomplete when he died. Throughout his life, new goals continually lay ahead. Each achievement was succeeded by a new and greater one, just as each of his larger telescopes carried astronomical knowledge farther and farther into the abysses of the night sky.



Not a new antiaircraft weapon, but an astronomical camera for photographing mysterious "zodiacal light"

"SUN GUNNERS" USE ODD SOLAR CAMERA

A SOLAR eclipse had a new kind of photographic instrument trained on it, last October, when the apparatus shown above was set up in Brazil by Prof. Charles H. Smiley of Brown University. Called a

Schwarzchild camera, it was designed especially to photograph the mysterious "zodiacal light" around the sun. Ordinarily this faint illumination can be seen only at dawn or twilight, extending upward from the horizon. Its source is generally believed to be reflected sunlight from a cloud of meteoric dust, extending outward from the sun beyond the earth. Hitherto, astronomers had tried in vain to catch the mysterious light with cameras of ordinary types used in solar photography.

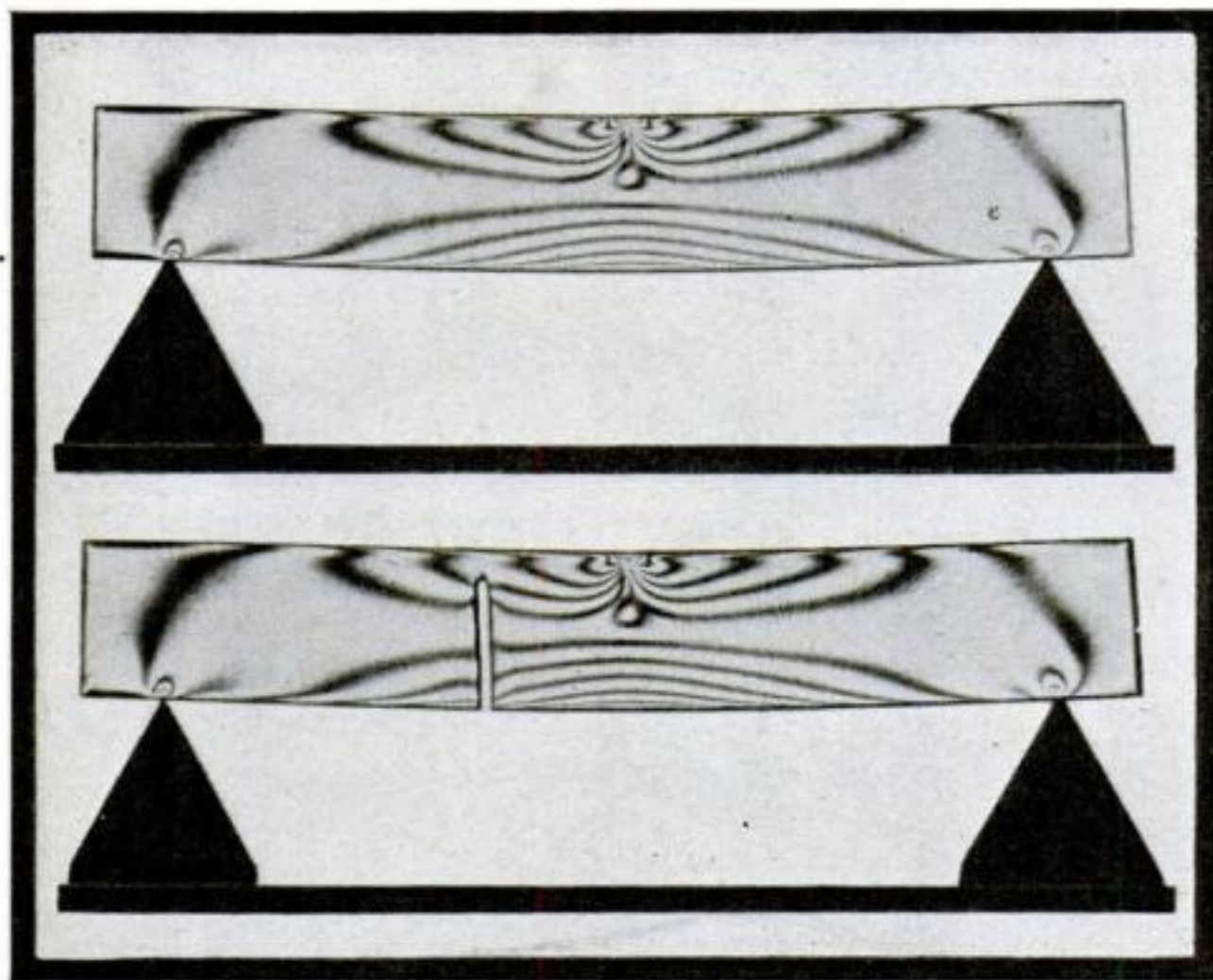
Wanted: An Electric Storage Battery Without Lead

WARTIME shortages of lead and nickel in Germany have inspired an effort to develop an electric storage battery that is independent of these materials, and the German Government has offered a prize of 10,000 Reichsmarks (about \$4,000) for its inven-

tion. It is pointed out that the development of a satisfactory leadless battery would not only make it possible to meet the requirements for gasoline-powered machines, but also enable electrically powered vehicles to be employed for many purposes.

Polarized Light

MAKES MACHINES SAFER



Stresses set up when a railroad-locomotive wheel delivers driving pressure on a rail are shown by the curved lines in the plastic model below, as they appear by polarized light



These photographs prove that after stress lines have been "frozen" in a sample by the new process, even a saw cut will not change the pattern

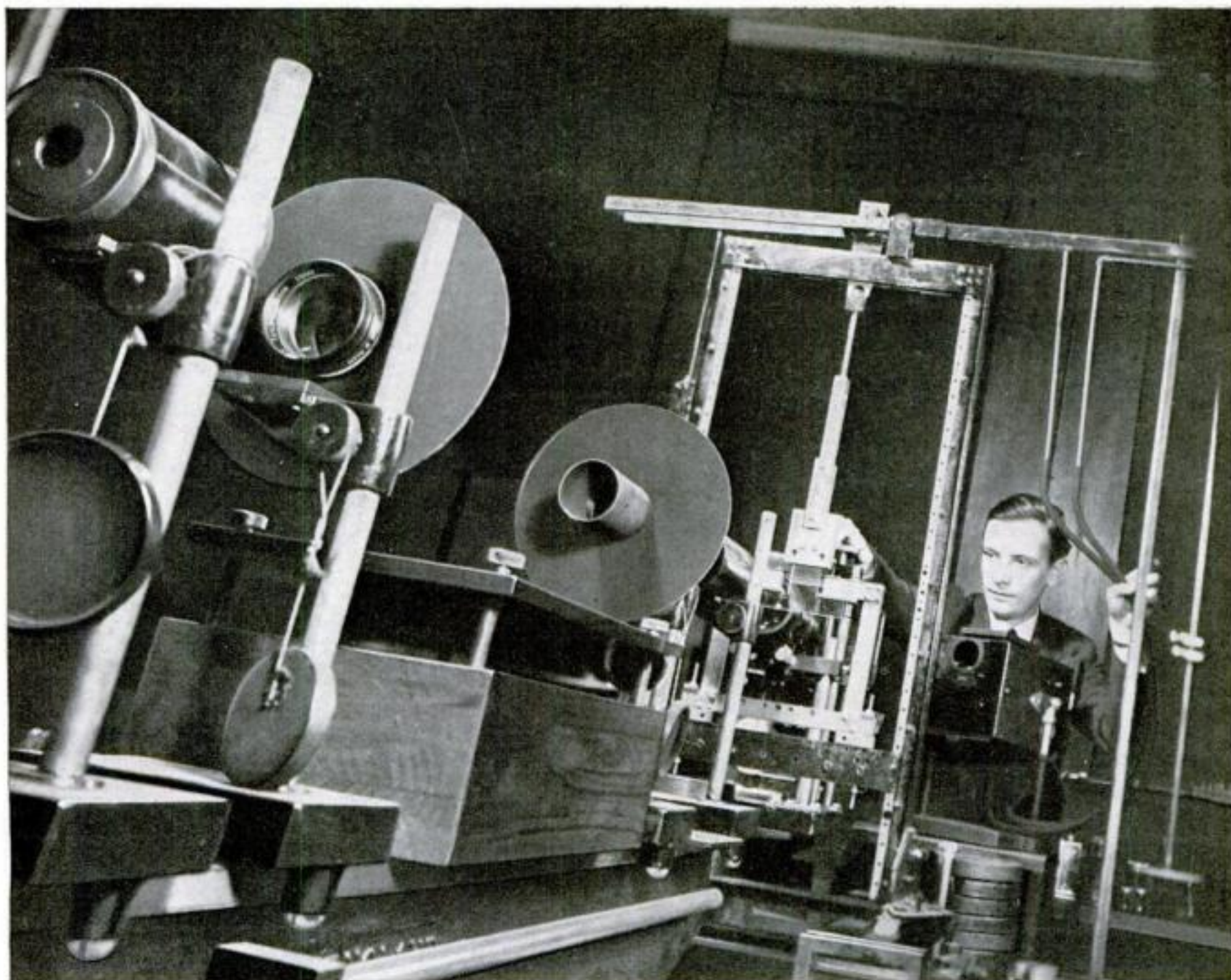


Racks like this hold "frozen stress" samples for observation in the novel tests. The two circular frames hold disks of a light-polarizing material

THROUGH a new technique called "frozen stress," Westinghouse research workers can now look inside a piece of railroad track, a gear wheel, a crane hook, or a spinning shaft, and see the danger points that might cause failure in service. Like earlier methods used by stress engineers, it applies a peculiar and beautiful phenomenon.

Viewed by polarized light, which vibrates in one plane, transparent models of machine parts exhibit rainbow patterns of color when subjected to internal stress, as by bending or twisting. The various colors show the amount of strain, much as contour lines indicate elevations on a map. This scheme has worked splendidly with flat and stationary objects.

Now the Westinghouse "frozen stress" method, for the first time, makes it possible to peer into various levels of deep, irregular objects by revealing the color fringes at each depth. In addition, it simplifies the problem of observing stresses due to centrifugal force in rotating parts, like the rapidly

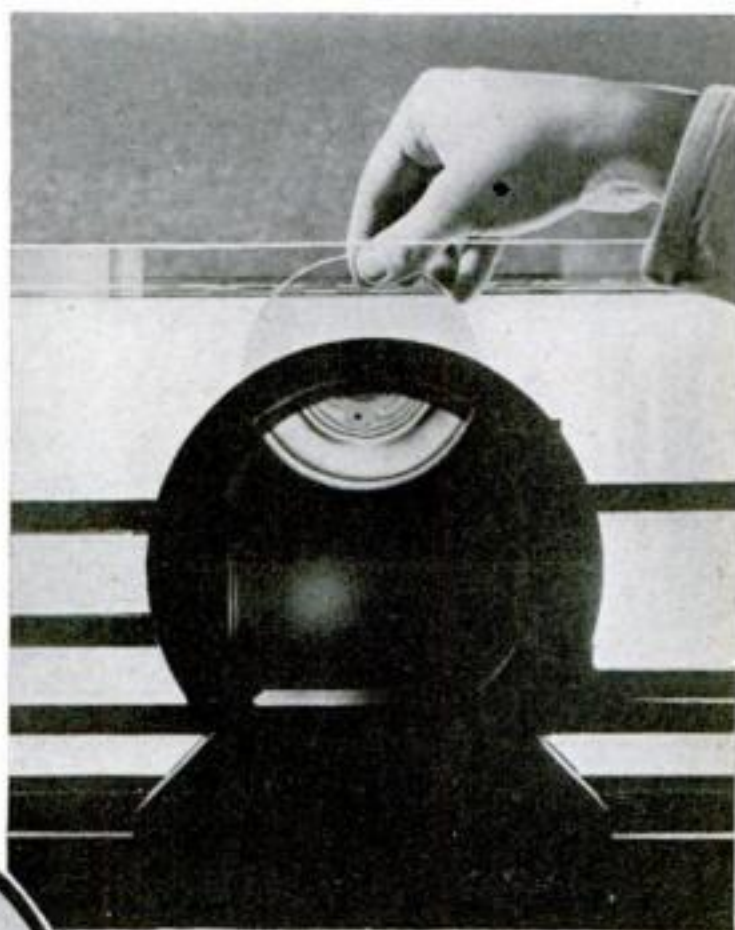


With this giant magic lantern, Westinghouse engineers can look into a model operating under strain

spinning rotor of a huge electric generator.

Bakelite models, placed in an electric oven, are loaded to simulate actual conditions and "cooked" for an hour at 240 degrees F. Part of the Bakelite, a sort of infusible skeleton of cells, remains solid and bends normally under the load. The rest liquefies within the cells. This fluid resin then solidifies as the oven cools to room temperature, "freezing" the whole model in its stressed and deformed shape. The model may be spun in the oven, during heating and cooling, with the same effect.

The resulting test samples have the advantage of being permanent and easily handled, requiring no further straining during examination. Best of all, they may be dissected like microscope specimens without disturbing the color-fringe patterns. Thus, thin sections can be carefully sawed from the test sample at graduated levels and observed in order, giving a complete three-dimensional picture of all stresses.



Stress patterns "frozen" into a bakelite disk as it rotated at a high speed are revealed when it is inserted between the polarizing disks. The photograph at the left shows the stress lines produced in a crane hook under load

WILLKIE OR ROOSEVELT?

HOW SCIENCE SPEEDS THE COUNTING OF 40,000,000 VOTES

HUMMING over wires from every corner of the nation, election returns in a few days will bring the answer to the question of America's 40,000,000 voters: Who's elected?

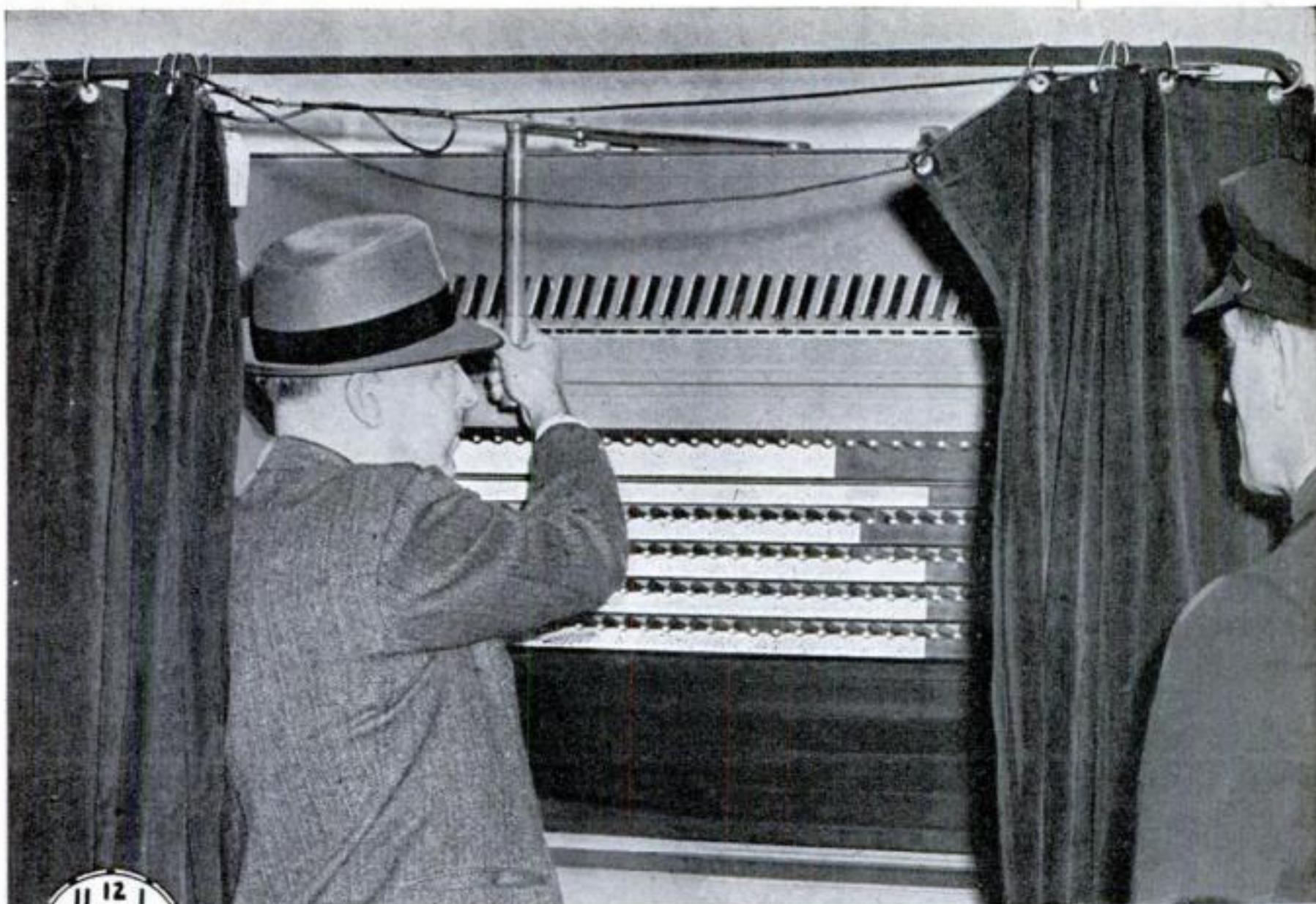
Years ago, many days would pass before positive results of a Presidential election were known. Today it is a matter of hours and minutes. To make this possible, a scientific network of communication machines—teletypes, telephones, telegraph, and radio—manned by an army of workers, has been recruited and promises the earliest election returns in history. But nothing will aid the vote gatherers more than the voting machines that this year number 35,000 in twenty-two states.

First used around the turn of the century, the voting machine, by reason of its speed, accuracy, and honesty, has come up in popularity until this year it will tabulate nearly a third of the votes cast.

So you may see how modern high-speed machines count the votes, POPULAR SCIENCE selected a typical Mr. and Mrs. America and, in the series of pictures that follows, starts you around the clock with them on Election Day and shows you how they may well know on the same night "who's elected!"

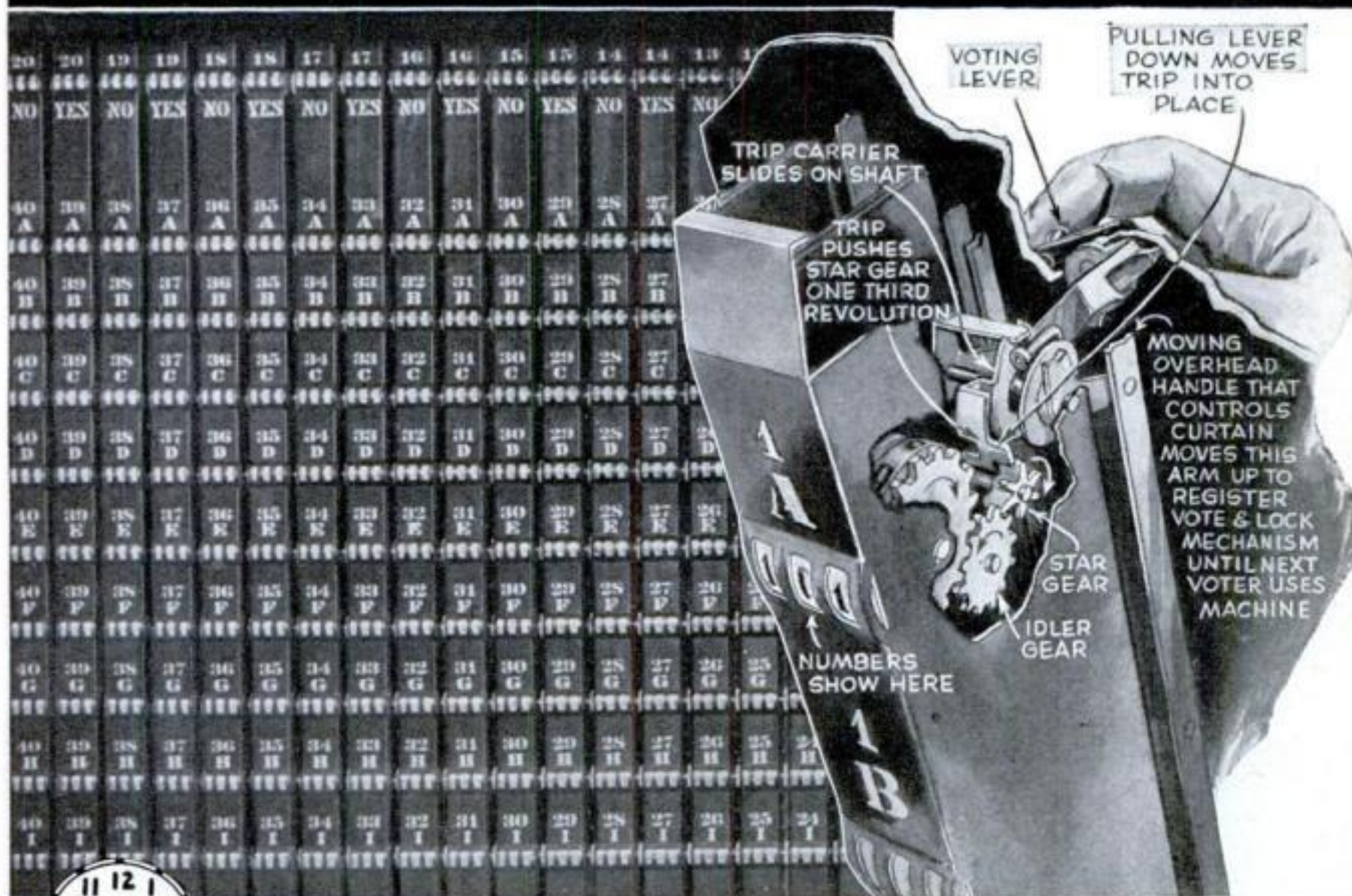


Mr. and Mrs. America about to leave their home for the polls. They will "cast ballots" (Romans used to do it by "casting" tiny "balls" into an urn) for their candidates. Most polls open at 6 or 7 A. M.



A.M.

Voting by machine, Mr. America is ready to move the handle to close the curtains around him. To vote, a lever over candidate's name is depressed. Returning the handle records his votes and reopens curtains



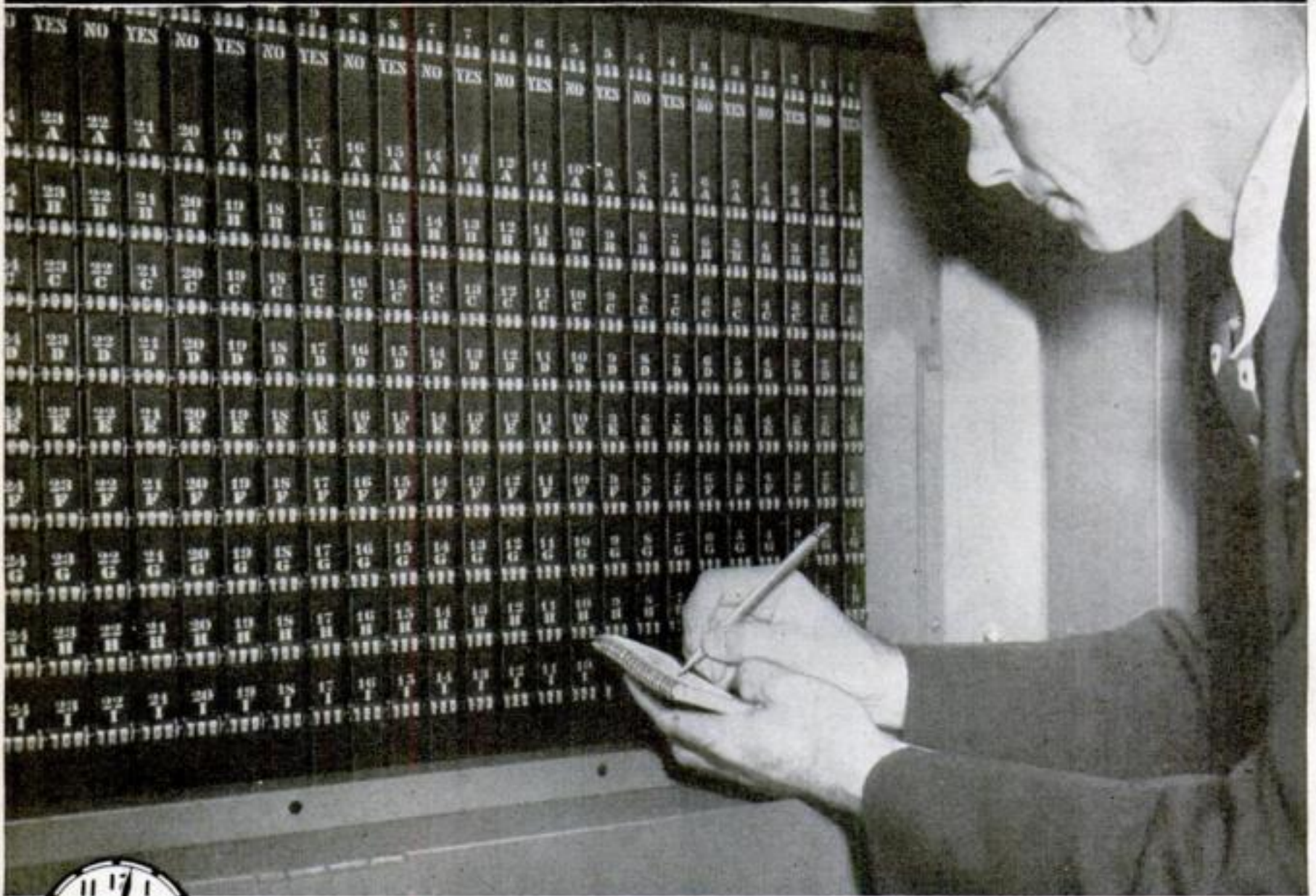
A.M.

Here's what happens. Depressing a lever merely "puts it in gear." He can still change his vote. When desired levers are down, mechanism is operated by main handle, recording the votes on wheeled counters



P.M.

Twelve hours after opening, the polls close. Here an official locks the machine against further voting, at the same time unlocking the hinged back revealing the rows of vote counters you see below



P.M.

Each counter serves a candidate. Copying recorded numbers is quick, and easily verified later, as a master key in possession of only the election-board chief would be needed to alter the registered totals



P.M.

Police carry copies of the returns from polling places to local precincts, thence to headquarters, finally to the election boards for counting. Presently, innumerable local and state returns are totaled



P.M.

By now, press associations begin to rush early returns through their teletype networks. Here you see teletype receivers recording bulletins in the National Broadcasting Company's New York City news room



P.M.

This statistician's work is an important step in the radio-news-room activities. He enters returns on a master chart, adds them speedily, and furnishes figures to editors who check scripts for the announcers

BLACK - LEADING

ELECTION CHART

RED - WINNER

ELEC. CTS	PRESIDENT			HOUSE			SENATE			GOVERNOR			STATE	TOTAL ELEC. DISTRICTS	PRESIDENT			HOUSE			SENATE			GOVERNOR
	D.	R.	OTHER	D.	R.	OTHER	D.	R.	OTHER	D.	R.	OTHER			D.	R.	OTHER	D.	R.	OTHER	D.	R.	OTHER	
0													NEB.	2,025										
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2													N.J.	3,577										
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													N.Y.	8,971										
													N.C.	1,866										
													N.D.	2,245										
													OH.											
													OK.											
													PA.	8,054										
													RI.	245										
													SC.											
													SD.	957										
													TENN.	2,281										
													TEX.	254										
													UTAH	801										
													VERM.	246										
													VIRG.	1,503										



P.M.

His findings are also posted on this huge chart for ready reference of script writers, editors, and announcers. Teletyped, phoned, or telegraphed bulletins keep pouring in the latest known results



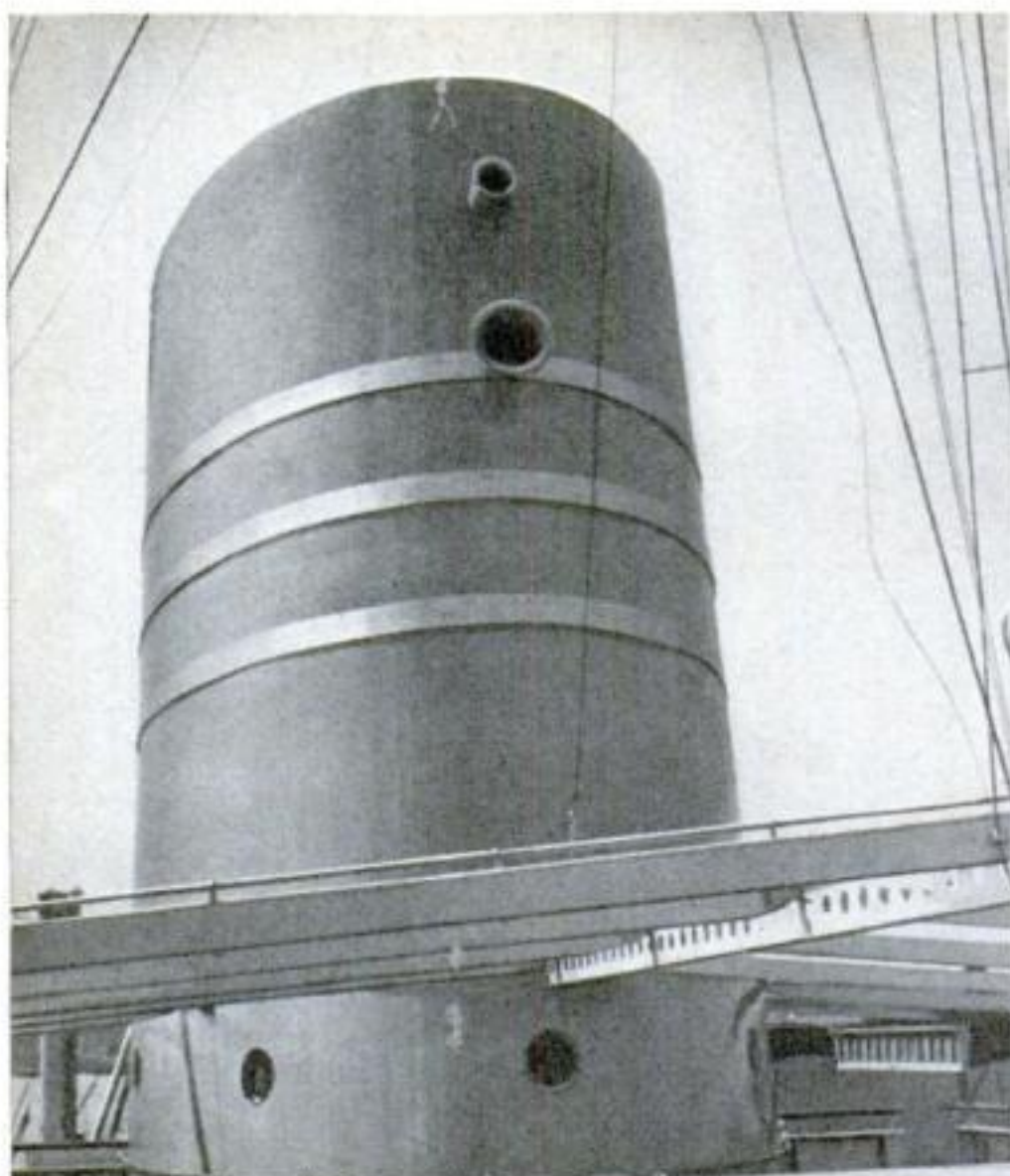
P.M.

As early as this on election night, Graham McNamee, George Hix, and others of N.B.C.'s staff, and equally famed announcers on other radio chains, are breaking into the scheduled programs with election news



P.M.

Just a few hours after the polls have closed, Mr. and Mrs. America wait tensely beside their home radio. They'll soon hear what they've wanted to know for weeks and months: Is it Roosevelt? Is it Willkie?



This passenger on the S. S. "Panama" is handing a radio message to the operator through a porthole in the ship's funnel. The dummy stack is pictured at the left



Liner's Radio Operator Works Inside the Smokestack

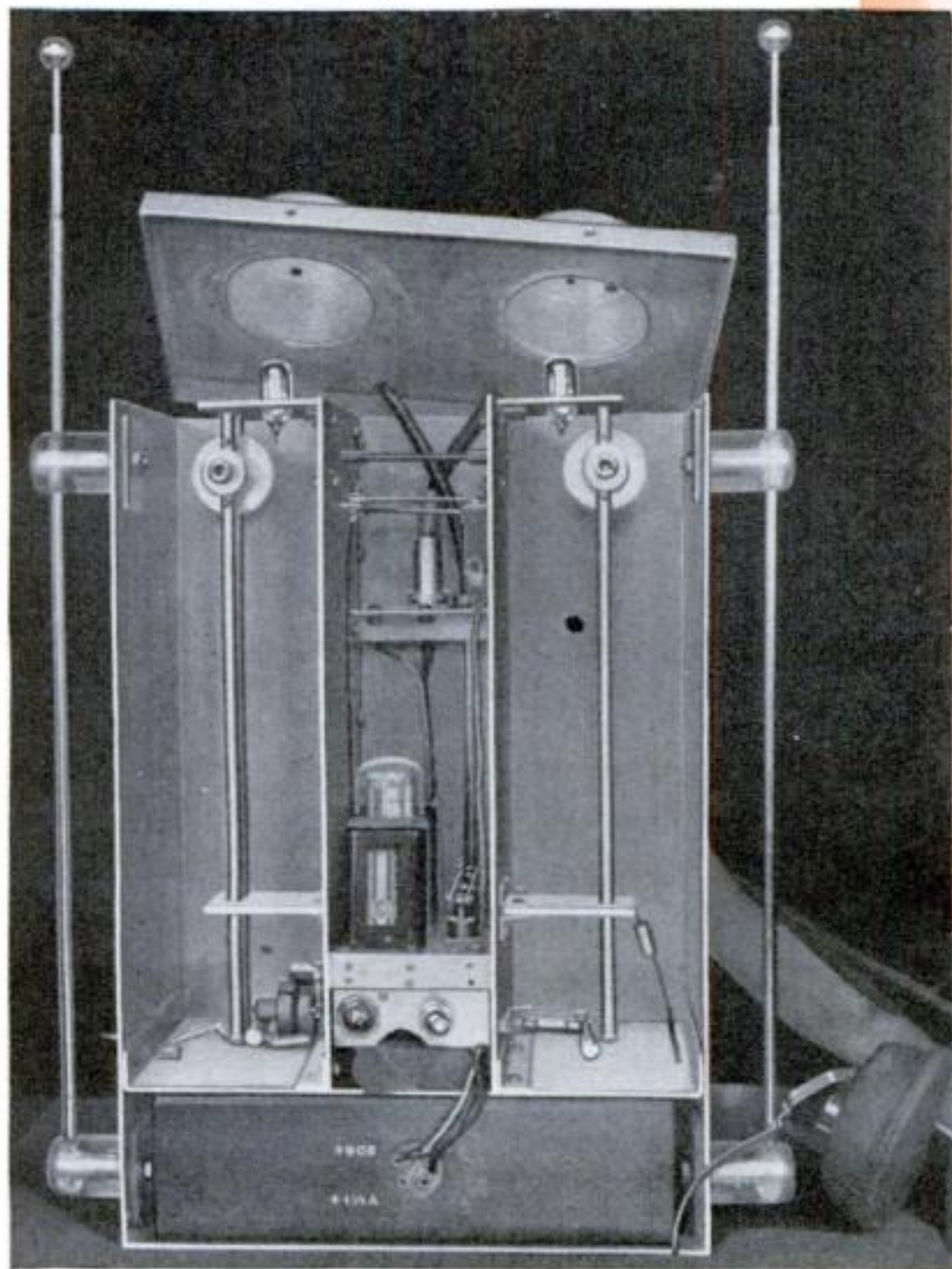
INSIDE the ship's smokestack is the unusual location of the radio room of the new American liner *Panama*. While the funnel, elliptical in section, measures seventeen by thirty-six feet, a twelve-inch pipe suffices to carry off the smoke of the engines. The remaining space in the dummy stack is divided into three levels, the first of which contains the completely equipped radio room, a comfortable stateroom, a storage room for deck-game equipment, and a spiral stairway that serves as a short cut to the captain's quarters below. On the second level, reached by means of a ladder, is a ventilator room housing engine-exhaust blowers. Up another story is a room where the ship's whistle may be reached for adjustment or repairs. Portholes admit fresh air to the rooms within the funnel, which are reached through a door that is curved to conform to the exterior contour. In the photograph at the right, the *Panama's* "Sparks" is seen in his unusual quarters.



Interior of the unusual radio room. The funnel also contains a stateroom, a storage room for deck games, and the ship's whistle

Two-Way Firemen's Radio Is Carried on the Back

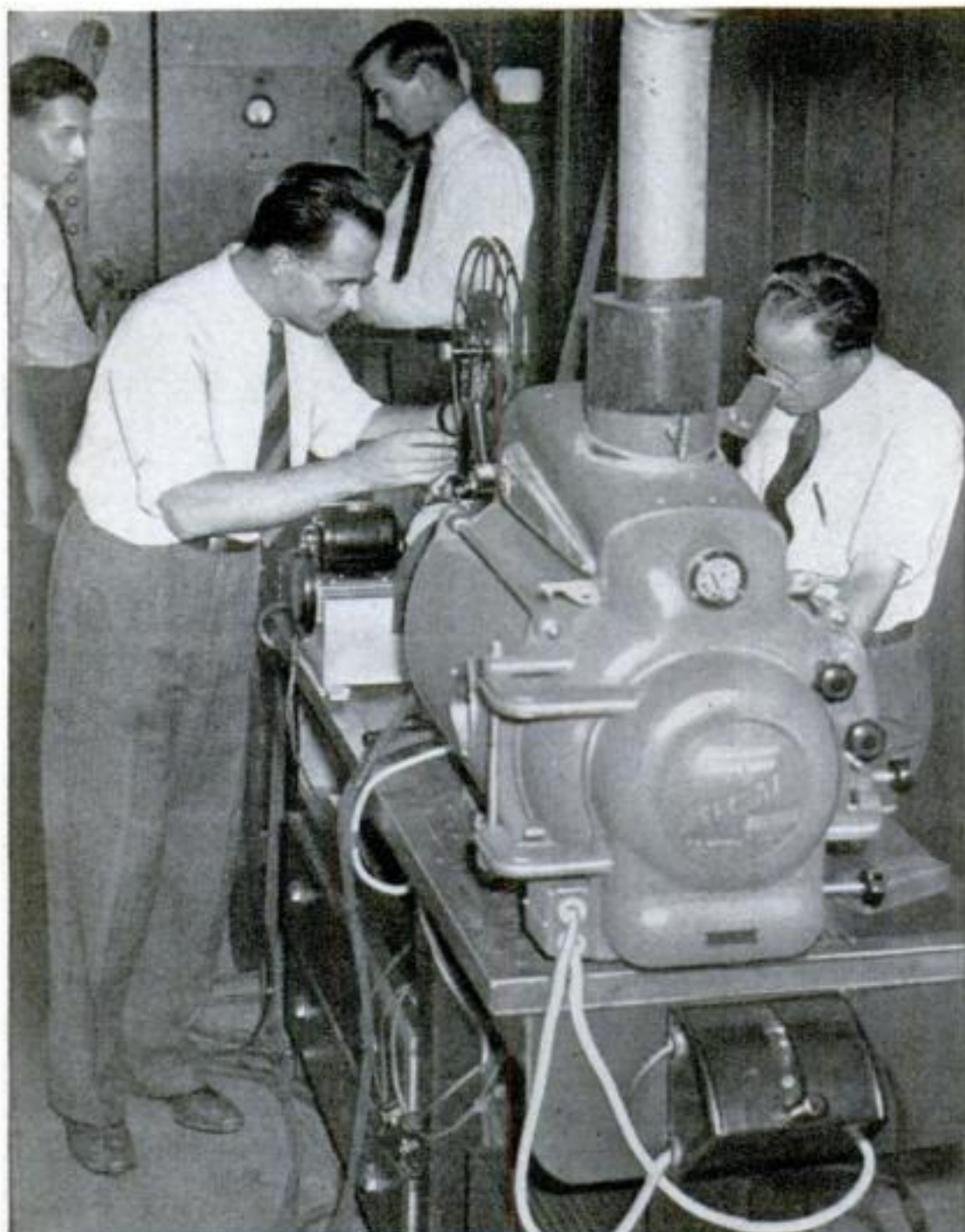
AS A result of months of research work by two New York firemen, Samuel Har-matuk and Arthur Meyerson, smoke eaters in America's largest city soon will be directed in fire fighting and life saving by means of lightweight, back-pack radios. Weighing only fifteen pounds, the two-way units can be slipped on over heavy fire-fighting clothing, leaving the hands free for climbing. A flexible cable controls the switch which shifts the set from transmitting to receiving and back again. The microphone is located on one of the shoulder straps of the harness and the earphones, of soft rubber, can be worn under a helmet. Tel-escoping antennas are located on either side of the waterproof case which houses the set. Power for the unit is supplied by dry-cell bat-teries with a life of seventy hours. The specially designed condensers are not affected by heat. During tests recently conducted by the New York Fire Department, the sets proved they had a range of as much as a mile. In use, they will enable a fire chief to talk to smoke eaters at work inside a burning building.



Fireman wearing back-pack radio. Note the microphone and switch cable attached to harness straps

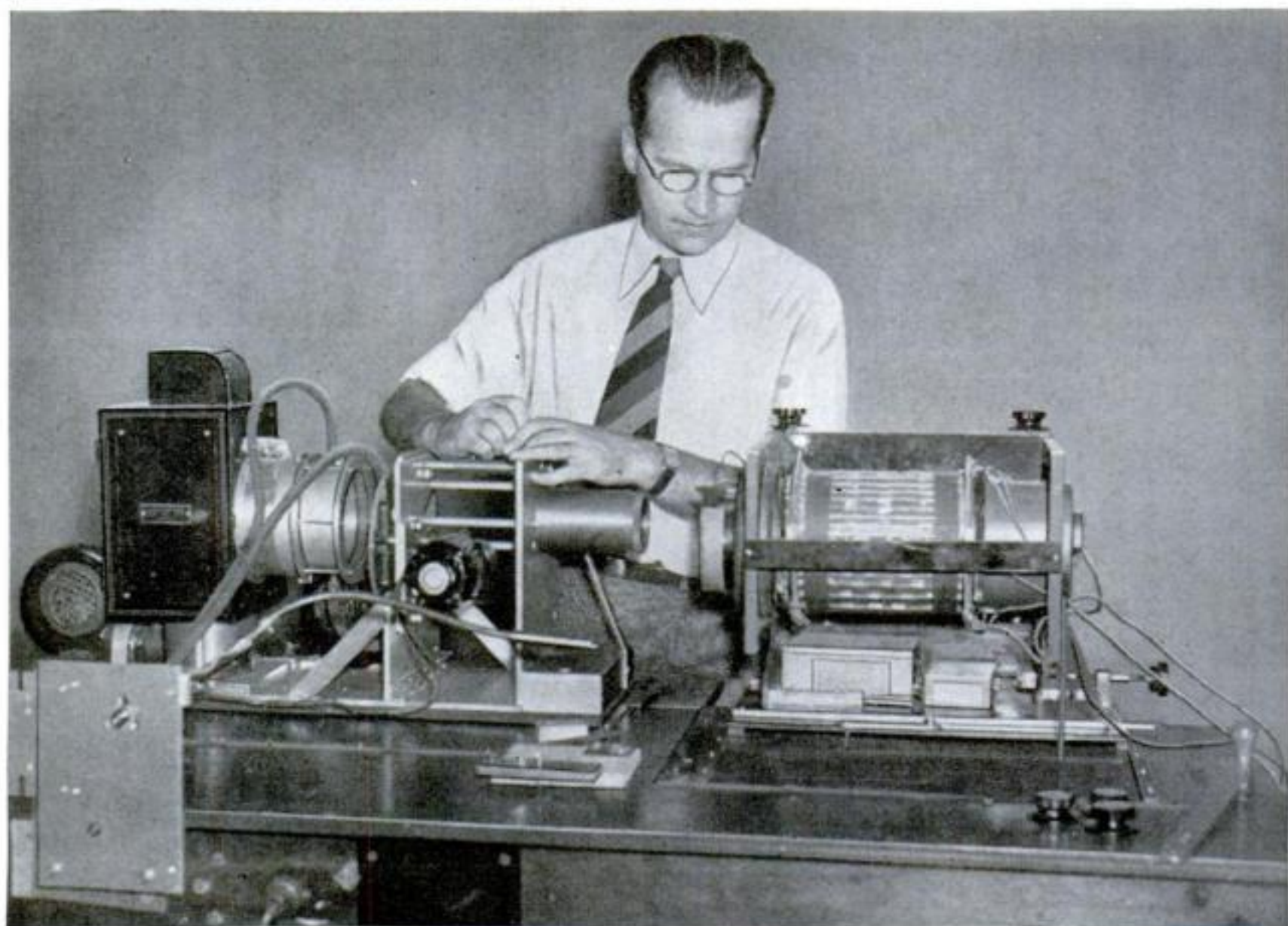
Weighing only fifteen pounds, the two-way unit uses a regenerative circuit and is powered by dry-cell batteries good for seventy hours

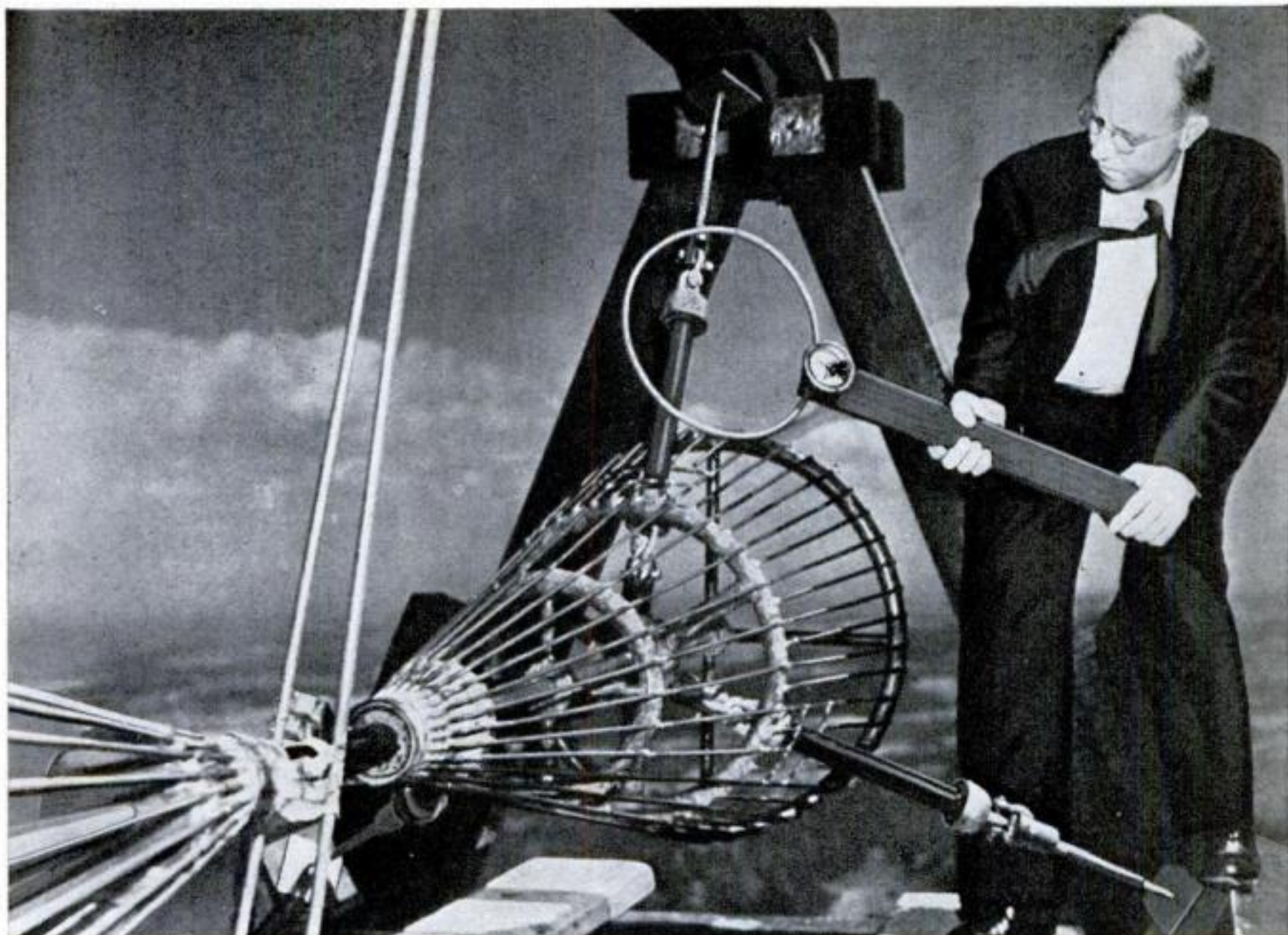
New Television System Transmits Images in Full Color



NATURAL-COLOR television, long in the experimental stage, may soon be on the air. A new process devised by Dr. Peter C. Goldmark of New York, and recently demonstrated by the Columbia Broadcasting System, transmits color movies successfully. The next step will be to adapt it to broadcasts of living subjects. At the transmitter, the image is scanned alternately on odd and even-numbered "lines." Rotating color filters give the sequence of red, green; blue, red; green, blue. Thus two full-color cycles serve for three pictures. This allows time for high-definition scanning of 343 lines or more. Viewed through synchronized filters at the receiver, the pictures all appear in natural color, since the eye retains one color image just long enough to blend it with the next two. When no color filters are used with the receiver, the image is black and white.

Television transmitter scanning colored movies. Below is the receiving end of the novel system





Basket-Shape Television Antenna Gets Broadcast-Power Tests

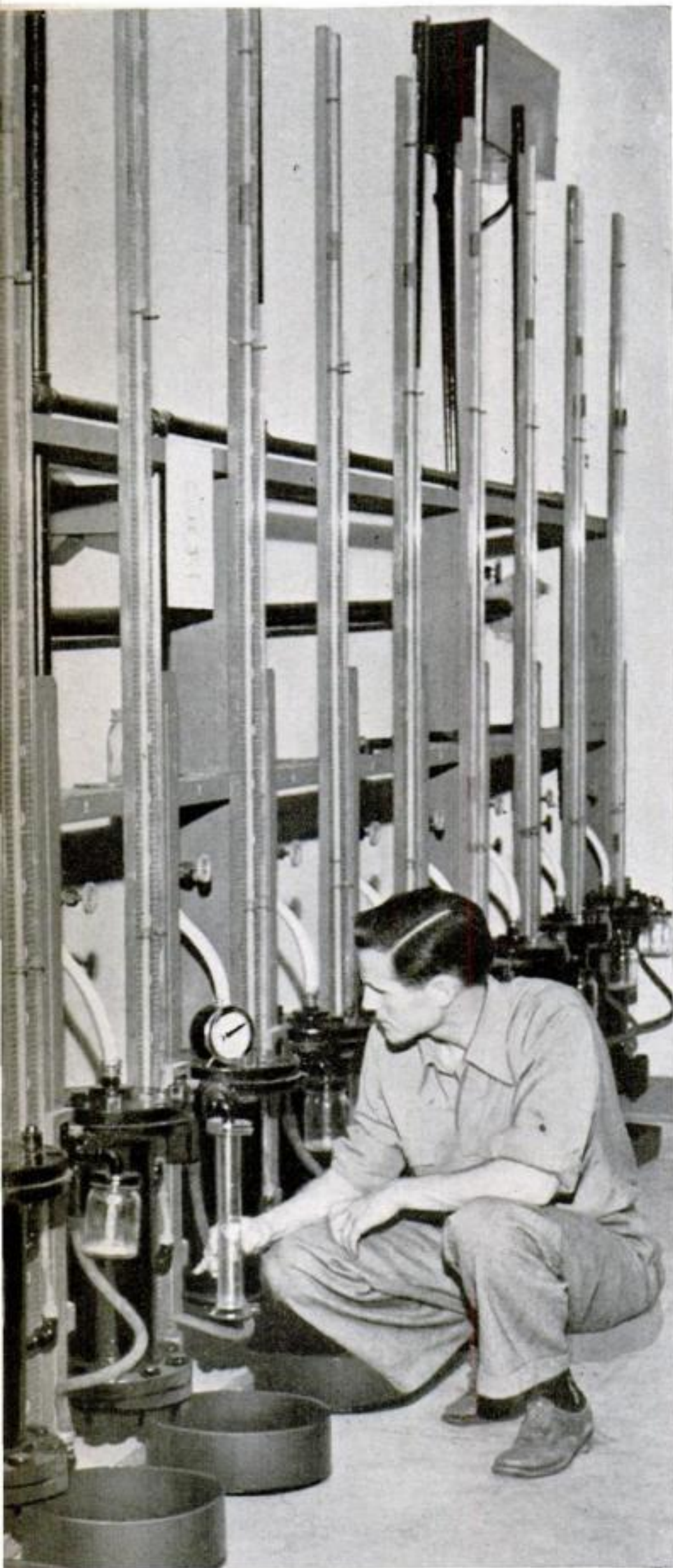
ASSUMING the stance of a butterfly collector about to pounce on his prey, the engineer atop the radio tower, above, is up to more serious business. His ring-shaped implement measures the strength of radio waves, and the even queerer-looking object in front of him is the latest in television antennas. By holding the ring in various positions, and reading a meter on its handle, he is testing the amount of power that the cagelike aerial radiates in different directions. Just perfected by General Electric engineers, this conical antenna has been erected at one of the company's stations near Schenectady, N. Y., where it will be used for future picture broadcasts. The photograph also illustrates how a good television site commands a view of the horizon.



Eavesdropping Mike Listens In on Umpire's Scraps at Ball Park

SO THAT baseball fans may eavesdrop on arguments between the umpire and players next spring, a "disappearing microphone" has been included in a new public-address system at a Wichita, Kans., stadium. Pressing a foot lever allows the microphone to pop from its underground box near the home plate. Through loudspeakers, the spectators then enjoy the novelty of hearing what is going on. In case a dispute becomes too heated for sensitive ears, the mike hastily retreats. As at left, it may also be used for announcements.

Torture Machines



A battery of permeameters, instruments that show how much water will seep through a given material

WALK along the crest of one of the many earth dams built by U. S. Army engineers throughout the nation, and you may wonder how grains of sand and silt and rocks can hold back flood waters. The answer is that every layer is subjected to a battery of torture tests by unusual machines which extract the innermost secrets of soils.

Testing devices perfected in the Los Angeles, Calif., district drip water through various dam-building materials, compress others until they no longer can be squeezed smaller, and shear tightly packed specimens until they split.

To small samples of soil, devices called consolidometers, which resemble large machine guns in firing position, apply pressure equal to that anticipated in the dam structure. As the thickness diminishes, micrometers indicate the change within a thousandth of an inch. Some of these machines apply loads up to twenty-eight tons to the square foot, more than would be exerted at the base of Mud Mountain Dam, an earth structure which rises 400 feet above the White River in Washington. The results show how much the materials will settle under various loads.

Will the foundation of a dam move under pressure? In the device below, samples of soil are tested for resistance to shearing



Test Soil for Big Dams

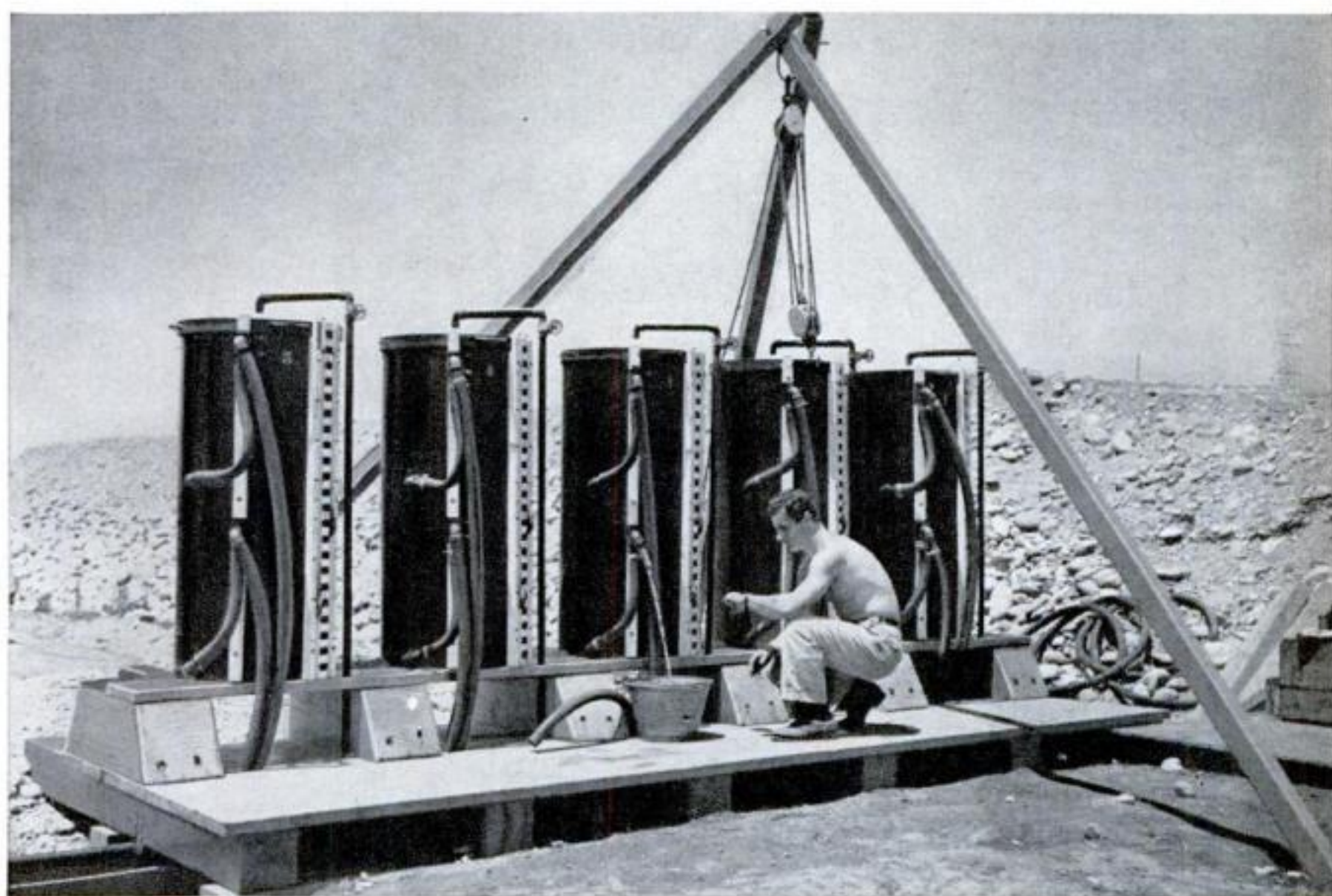
Permeameters receive samples whose density and weight have been recorded. These devices consist simply of tubes into which soil samples are placed, and containers permitting water to ooze through the samples. By this means, the engineers determine both the density required for various materials and the various parts of the dam to which they will be allocated. Larger permeameters in the field take coarser materials, including six-inch rocks.

To determine whether foundation materials underlying the huge structures will move under pressure, compacted samples are submitted to powerful shear machines. Each double handful of soil is packed tightly in a double box. For several days, pressure equal to that sustained in the field is applied. Then the upper half of the box is elevated a sixteenth of an inch, and slowly,

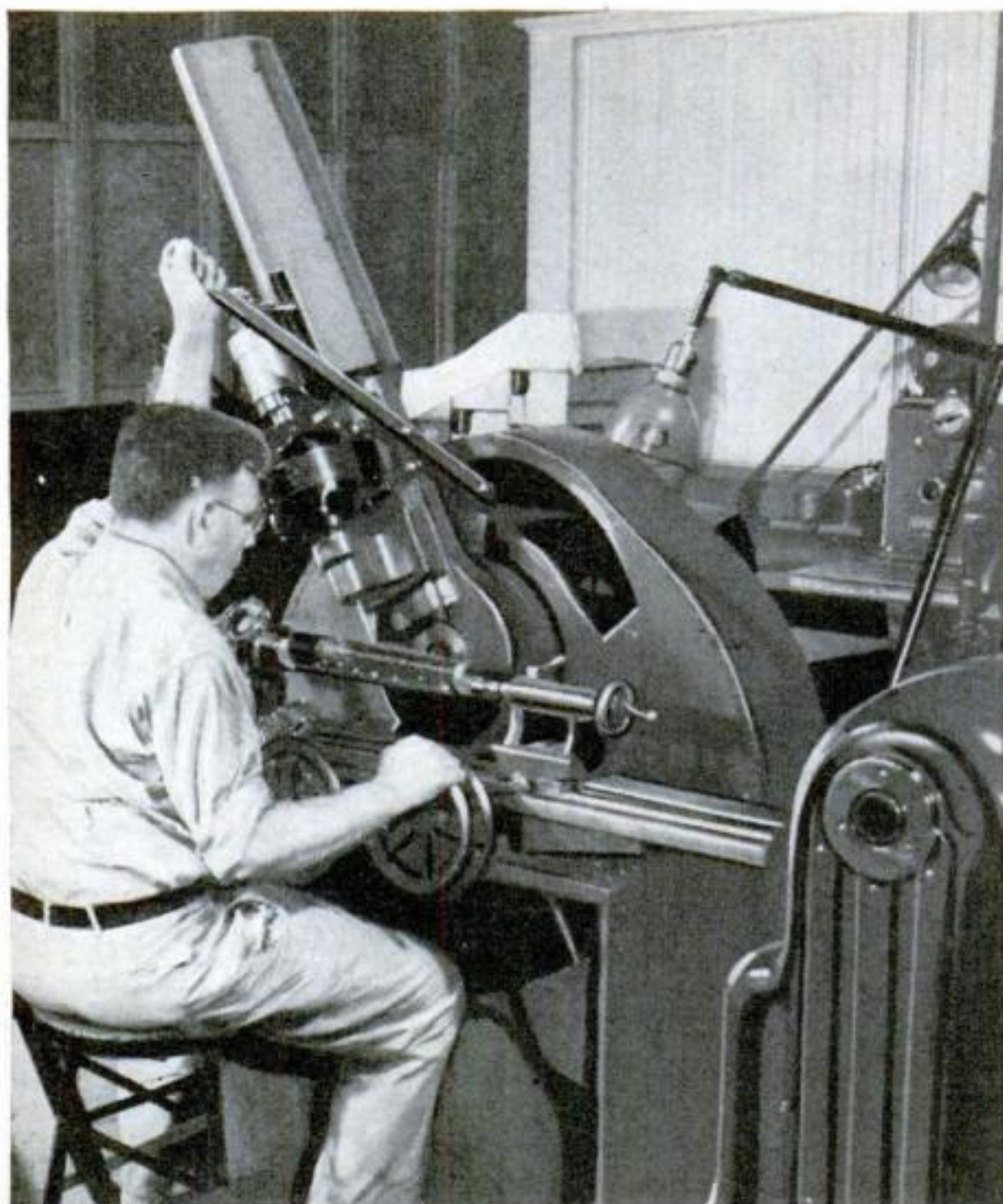


Putting the squeeze on soils: samples compressed in these machines reveal the extent to which a dam foundation will settle under load

while one hydraulic jack maintains tremendous vertical pressure, another shoves sideways until the sample splits in half as instruments register the forces required.



Coarse materials, including rocks, are tested for permeability in the field, in large tanks like these



Operating the machine that shapes bassoons, then drills the tone holes

Odd Machine Makes First U. S. Bassoons

PRODUCED by the necessities of war that has cut off the foreign supply of musical instruments, the first machine made in America for turning out bassoons recently began functioning in an Elkhart, Ind., factory. In prewar days, these instruments were imported from Europe. Because the body has to be turned out with an oval shape and the tone holes must be drilled into the body at different angles, these instruments are hard to produce. The Indiana machine, a combined lathe and drilling apparatus, speedily turns out the body of the instrument and then drills the holes as required.

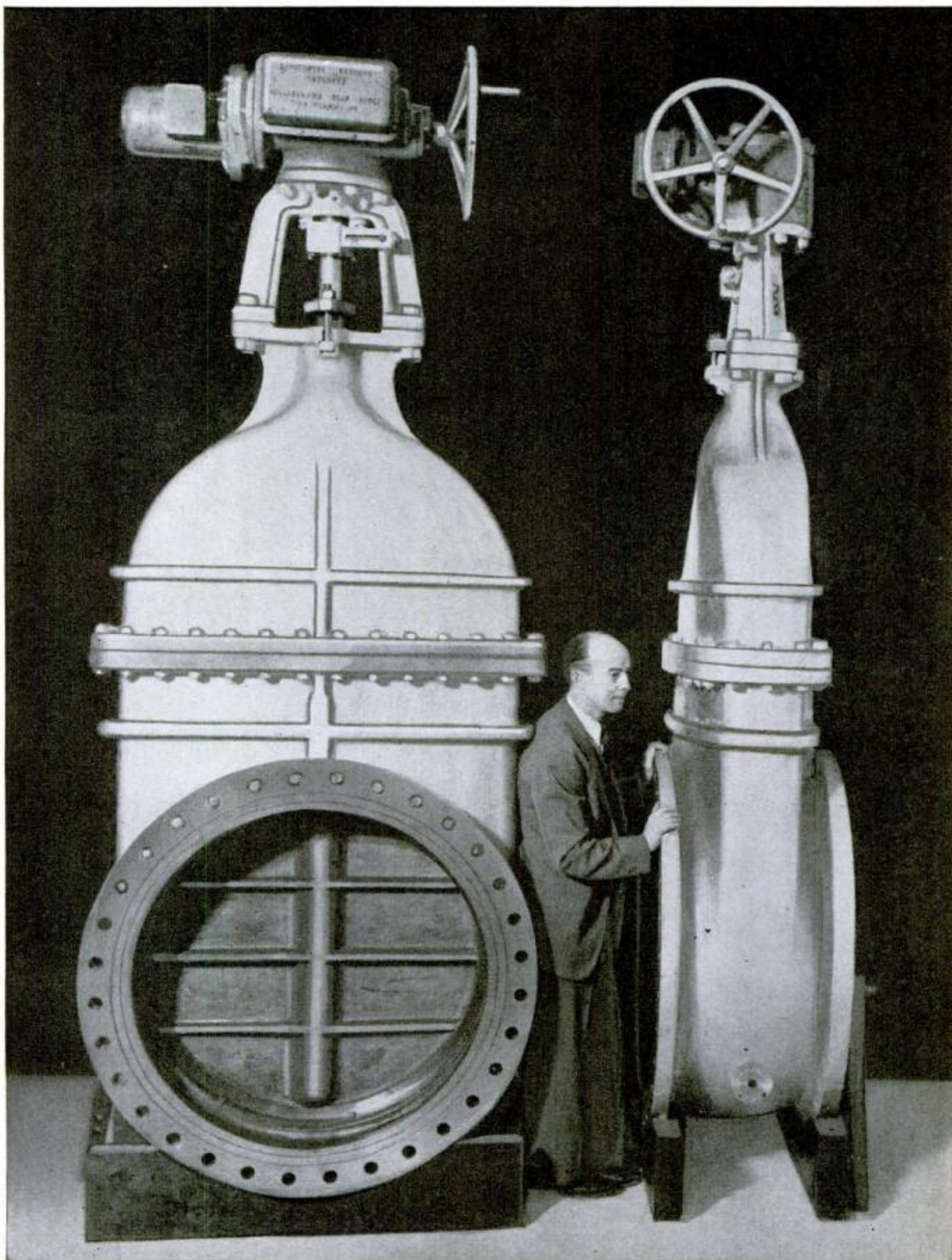
Rubber Tires Replace Iron Rollers To Pack Road Soil

BATTERIES of close-set rubber tires are now replacing clanking, ponderous iron rollers in packing down the soil for new highways. The specially designed tires, with smooth treads, are placed side by side

in two series, one just ahead of the other. Their treads are staggered so they cover all the ground in a given strip. Nine of the tires, five behind and four in front, support the weighted framework of the novel roller.



The close-spaced giant tires, heavily weighted, are said to pack soil more effectively than iron rollers



Giant Valves Made for Biggest American-Built Liner

WEIGHING more than 5,000 pounds apiece, four giant valves twice as tall as a man were specially constructed for use on the *America*, the largest passenger liner ever built in this country. Installed in the circulating condenser lines of the vessel, the

valves have an opening thirty-six inches in diameter. Solid wedge-type bronze disks, weighing 1,000 pounds apiece, close the openings when the valves are shut. Motor-operated, the valves are the largest ever ordered for the American merchant marine.

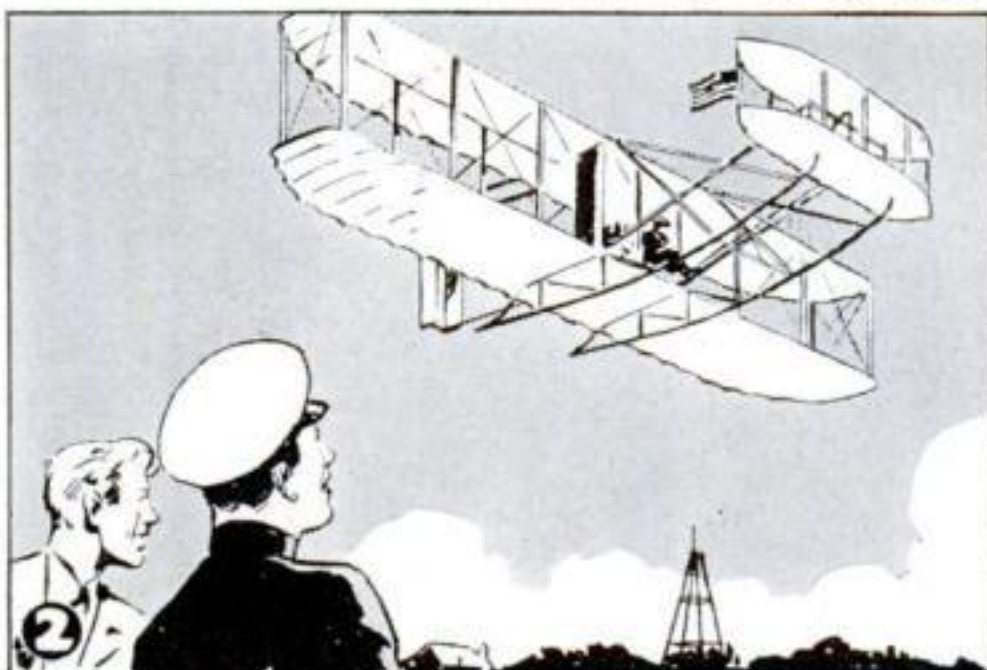


Here's My Story

DONALD WILLS DOUGLAS WAS BORN IN BROOKLYN, N.Y., APRIL 6, 1892



1 AT 17, IN 1909, HE ENTERED THE U.S. NAVAL ACADEMY AT ANNAPOLIS



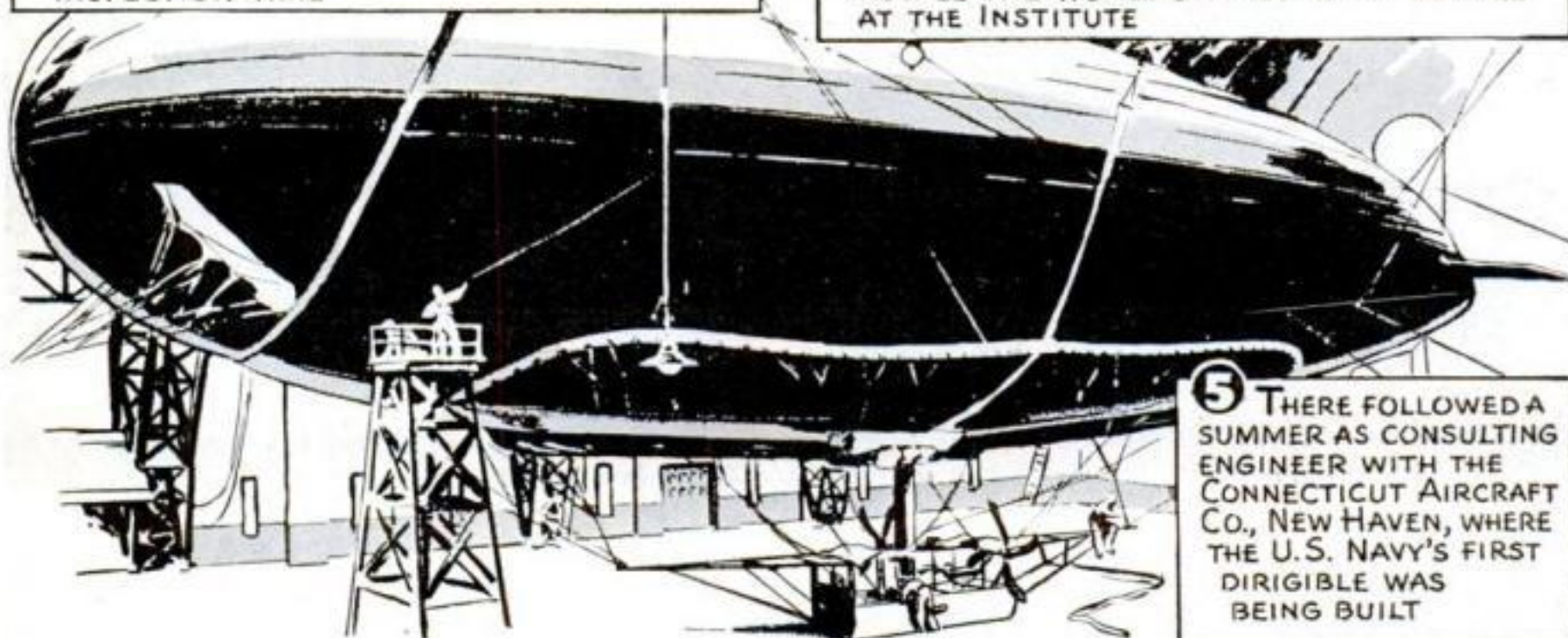
2 THE SAME YEAR, WHEN ORVILLE WRIGHT FLEW THE ARMY'S FIRST BIPLANE IN ACCEPTANCE TESTS AT FORT MYER, VA., YOUNG DOUGLAS PRIED OPEN HIS SAVINGS BANK TO GET MONEY TO GO AND SEE HIM



3 AFTER THAT, HE READ EVERYTHING HE COULD LAY HIS HANDS ON ABOUT AVIATION. BUILDING MODELS, HE FLEW THEM FROM THE DORMITORY ROOF—HID THEM AT INSPECTION TIME



4 TRANSFERRING TO THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY TO STUDY AERONAUTICS, HE GRADUATED IN 1914. HIS FIRST JOB—AT \$500 A YEAR—WAS TO HELP INSTALL THE WORLD'S FIRST WIND TUNNEL AT THE INSTITUTE



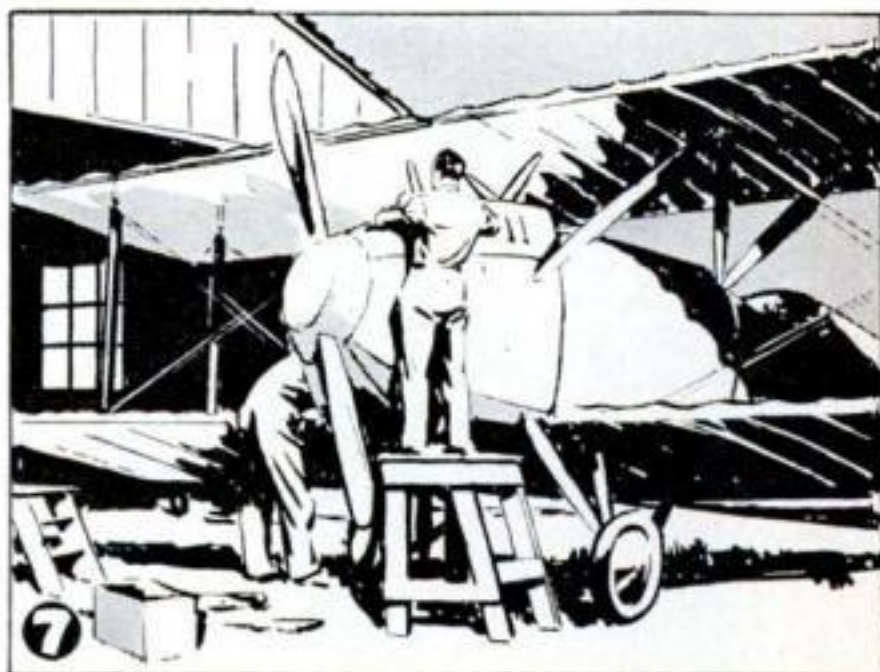
5 THERE FOLLOWED A SUMMER AS CONSULTING ENGINEER WITH THE CONNECTICUT AIRCRAFT CO., NEW HAVEN, WHERE THE U.S. NAVY'S FIRST DIRIGIBLE WAS BEING BUILT

THE CAREER OF DONALD W. DOUGLAS

DOUGLAS
— FIRST
AROUND
THE WORLD



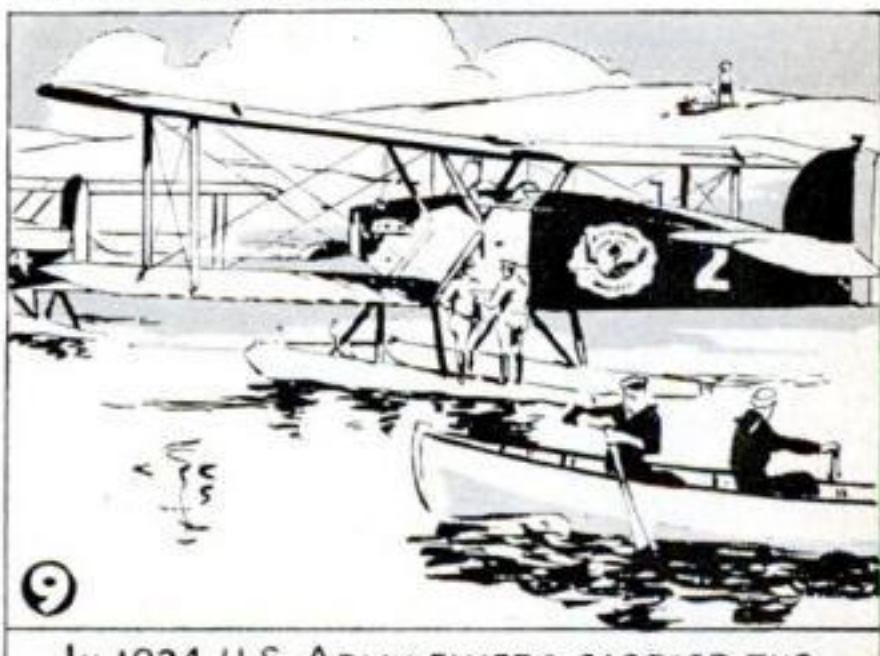
6 IN 1915, DOUGLAS WENT TO THE GLENN L. MARTIN PLANT IN CALIFORNIA AS CHIEF ENGINEER. AFTER THE COMPANY HAD MOVED TO CLEVELAND, OHIO, HE DESIGNED THE FIRST OF THE FAMOUS MARTIN BOMBERS



7 BACKED BY A HOLLYWOOD SPORTSMAN, IN 1920 HE BUILT THE "CLOUDSTER"—FIRST PLANE TO LIFT A USEFUL LOAD EQUAL TO ITS OWN DEAD WEIGHT. THE FIRST DOUGLAS FACTORY WAS A ROOM BEHIND A BARBER SHOP



8 ARMED WITH BLUEPRINTS FOR A TORPEDO PLANE, HE INVADDED WASHINGTON, D.C., A LITTLE LATER AND LANDED A \$120,000 NAVY CONTRACT FOR THREE OF THE CRAFT



9 IN 1924, U.S. ARMY FLYERS CARRIED THE FAME OF DOUGLAS MILITARY PLANES AROUND THE WORLD, MAKING THE FIRST CIRCUIT OF THE GLOBE IN DOUGLAS SHIPS WITH LIBERTY MOTORS



10 ALL-METAL DOUGLAS TRANSPORTS APPEARED IN 1932 AND SOON WERE CARRYING PASSENGERS AN AVERAGE OF 350,000 MILES A DAY IN THE U.S. AND 22 FOREIGN COUNTRIES. DOUGLAS HAS WON THE HIGHEST HONORS IN AVIATION, THE COLLIER TROPHY AND THE GUGGENHEIM GOLD MEDAL. TODAY HIS CALIFORNIA FACTORIES EMPLOY 17,000 WORKERS



Arcs traced by fixed lights show vibration of George Washington Bridge

Night Picture Catches Bridge Doing a Shimmy

How a big suspension bridge "shimmies" under passing traffic has been demonstrated photographically by Lilo Maier, New York camerawoman. Steadying the camera on a hand rail of the George Washington Bridge and pointing it toward the approaches, she made the fifteen-second time exposure at the left. Disregarding luminous streaks made by headlamps of moving automobiles, she points out that all fixed lights show up as short, vertical arcs, which reveal the vibration of the bridge more graphically than any engineering formula. Anyone can duplicate the experiment with the simplest of cameras by properly adjusting the exposure time.

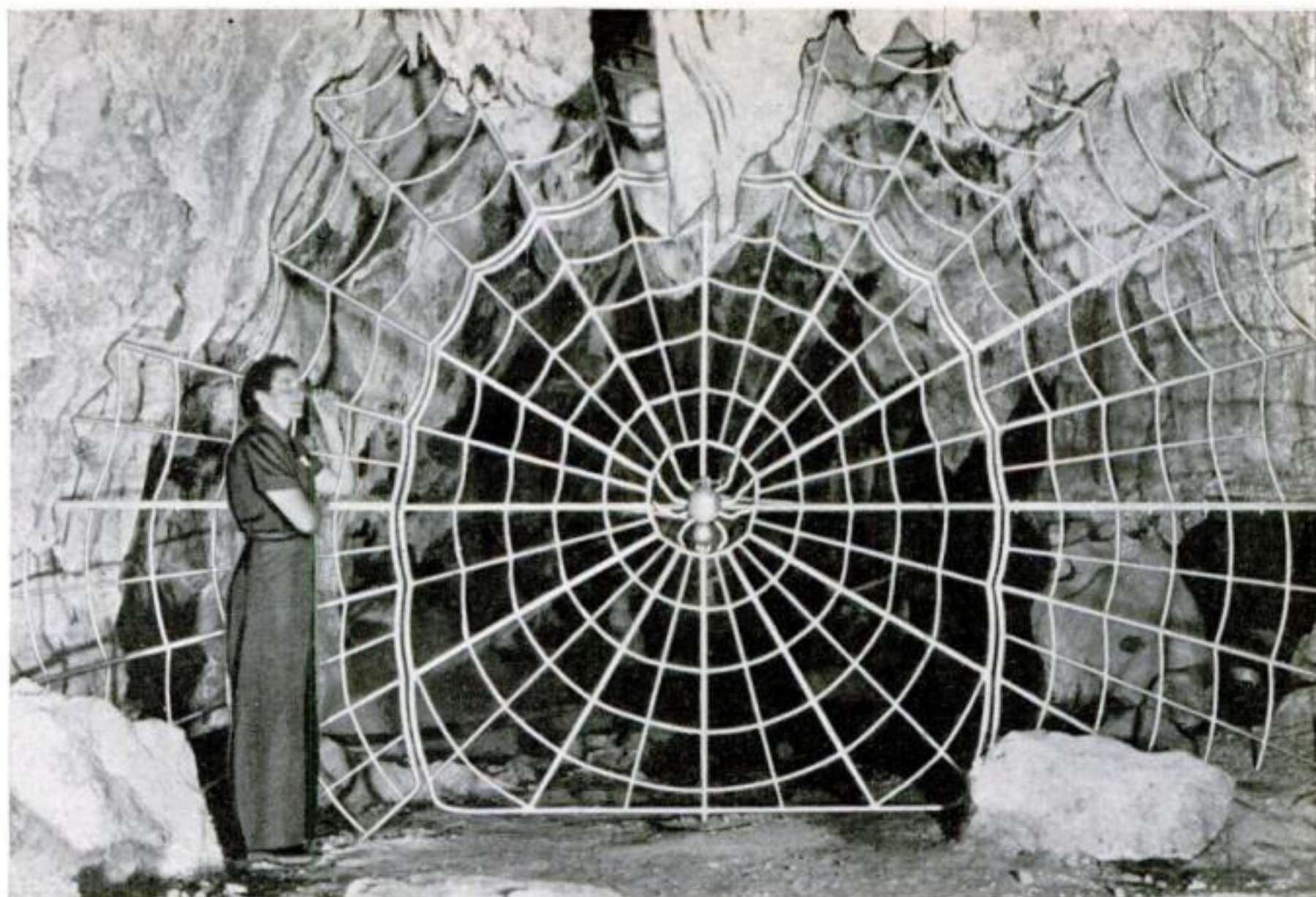
West Is East as Elephant Plows South Carolina Field

IT MIGHT be a scene in a far-away India, but the picture below was taken near Camden, S. C. The elephant's name is Alice, and she's pulling a disk harrow on the plan-

tation of Matthew Ferguson, sportsman. Though neighbors are said to be nervous about the possibility of Alice going on a rampage, she seems quite peaceful.



Guided by an American mahout, the elephant Alice patiently drags a harrow on a southern plantation



"Spider Web" Forms Gate to Subterranean Wonderland

PATTERNED after a spider web, the silvery gate shown above admits visitors to Crystal Cave in Sequoia National Park, Calif. Its lacy design is in keeping with the delicate beauty of stalactite and stalagmite

formations that sight-seers will find within the cavern. Illuminated to best advantage, these natural jewels, sparkling in their rocky setting, form an underground fairyland newly opened to the public.

Tiny Grand Piano Can Be Played with a Toothpick

FOUR craftsmen took six months to build a two-inch-square working model of a Steinway grand piano, illustrated at right. Played with a toothpick, it has thirty-six ivory keys and is strung like a full-size instrument. With other objects in the photo—miniature enamel furniture, and a dancing girl's toe bell from Bombay, India, displayed on a finger—it forms part of a private collection of 28,500 curios from fifty-four countries exhibited recently in San Francisco.



Miniature piano and furniture. Note Indian dancer's toe bell on finger



Forepaws around the tree, the dog kicks himself up

Climbing Dog Can Tree Himself

WITHOUT a running start, a climbing dog owned by Aaron T. Sack, of Lowell, Wis., is able to shinny up trees to a height of sixteen feet. The animal climbs straight up by placing its forepaws around the trunk of the tree and pushing up by means of its hind feet.

Want to Build Your Own Car?

AUTOMOTIVE engineers recently calculated how much it would cost to turn out a modern automobile by hand. The same machine which costs less than \$700 when produced in quantity by mass-production methods, would cost about \$17,850 if made altogether by hand.

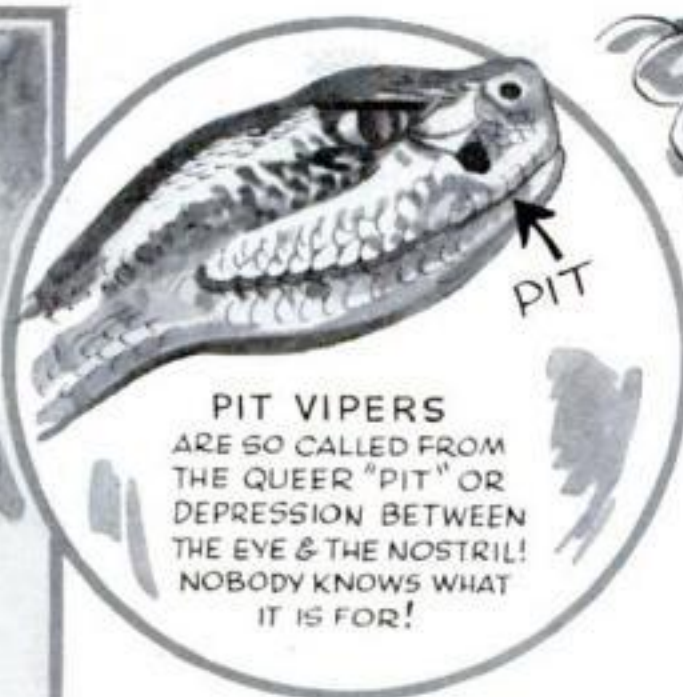
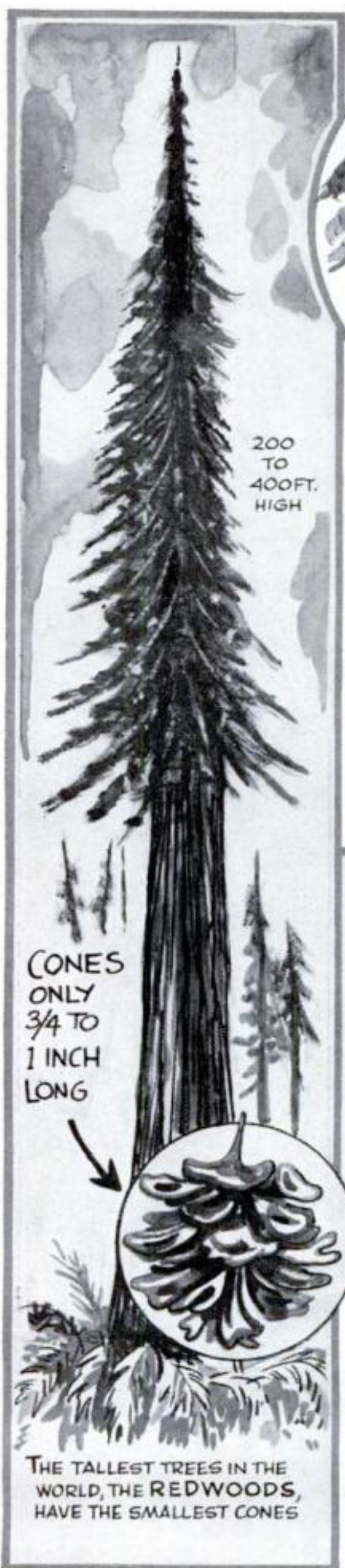
"Home, James" by Tandem Bike

WITH gasoline impossible to obtain for use in private automobiles in Denmark, wealthy Danes hire chauffeurs to take them to and from work on tandem bicycles. Such cycle-chauffeurs do the steering and most of the pedaling. Since July, the number of bicycles in Copenhagen has jumped from 1,750,000 to 3,800,000.



A Danish business man starts home after a hard day at the office

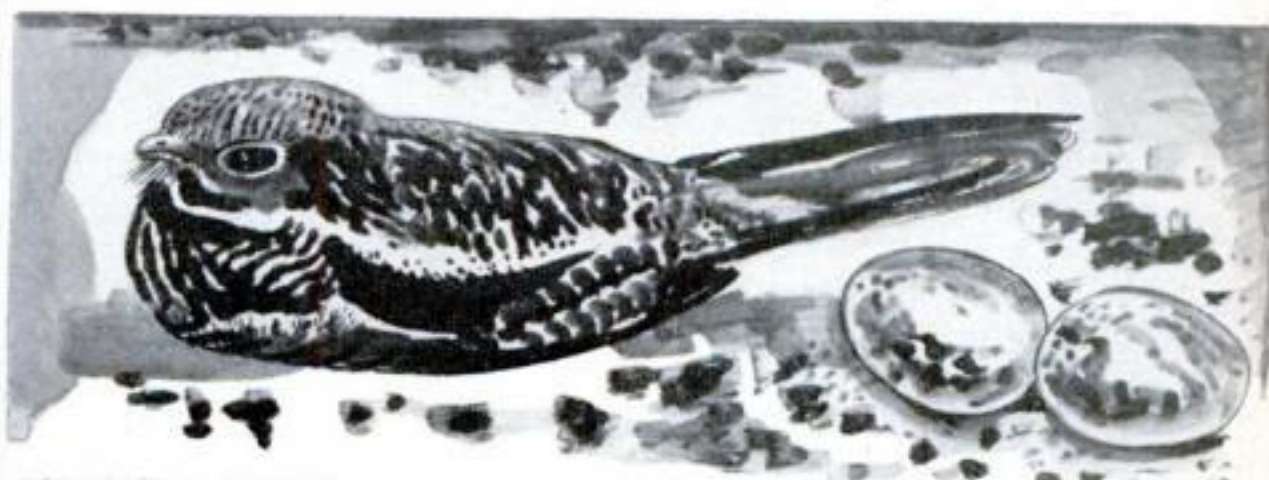
Un-Natural History BY Gus Mager



PIT VIPERS
ARE SO CALLED FROM THE QUEER "PIT" OR DEPRESSION BETWEEN THE EYE & THE NOSTRIL! NOBODY KNOWS WHAT IT IS FOR!



LIKE THE EUROPEAN CUCKOO, THE FLORIDA TERRAPIN LEAVES ITS EGGS ON OTHER CREATURES' DOORSTEPS! IT OFTEN LAYS IN AN ALLIGATOR'S NEST, LEAVING THE EGGS TO BE HATCHED WITH THE SAURIAN'S BIG CLUTCH....



NIGHT HAWKS
NEVER BUILD A NEST OF ANY KIND! WHETHER IN A ROCKY PASTURE OR ON A CITY ROOF, THE TWO EGGS ARE LAID RIGHT OUT IN THE OPEN, AND THEY ARE SO WELL CAMOUFLAGED THAT THEY ARE SELDOM DISCOVERED!



IT NEVER RAINS CATS AND DOGS, BUT FISH AND FROGS DO FALL FROM THE SKY! IN DRY PRAIRIE REGIONS, CLOUD-BURSTS HAVE BEEN KNOWN TO DROP SALAMANDERS WHICH HAD BEEN CARRIED FOR GREAT DISTANCES!



SAILORS SAY THAT WHEN PORPOISES ARE HARPOONED, THEY CRY LIKE BABIES....

New Appliances

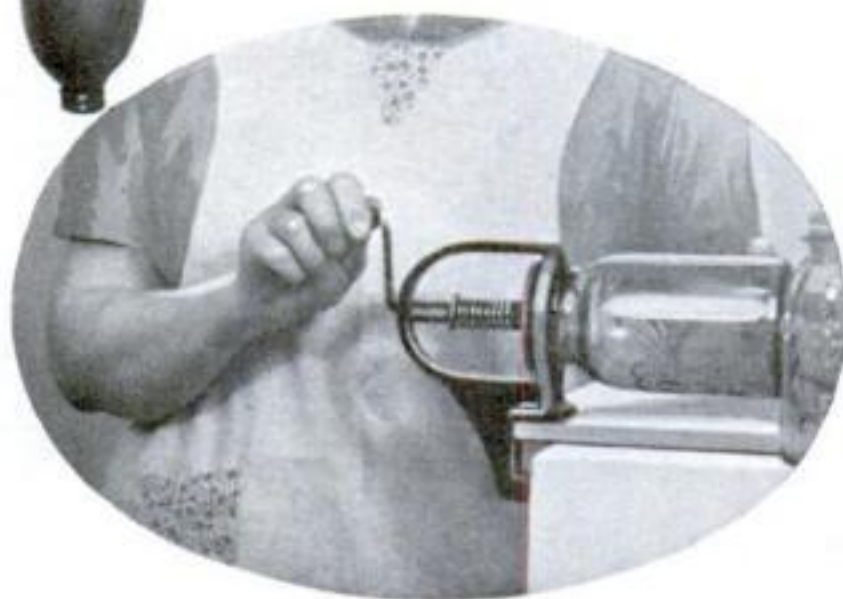


COLD-STORAGE FOOD LOCKER. Buying of food in large quantities when prices are low is made possible by electrically operated cold-storage receptacles designed for use in homes



FLASH-LIGHT DARNING EGG

Inserted in hosiery or under fabrics being mended, this darning egg lights the work. It has a bulb in its blue plastic head, and cells in the handle



FRUIT-JAR CONDITIONER. Irregular and chipped edges of glass fruit jars, a frequent cause of food spoilage, are easily ground to smoothness with this kitchen tool, which works on all standard glass fruit jars



GARBAGE-DISPOSAL UNIT. Any kitchen sink can be equipped for the "down-the-drain" system of refuse disposal, by installing the electrically operated unit illustrated above



SHOE RACK

Fastened to the door of a closet, this convenient rack holds shoes in small space. Footgear is easily hung up by means of spring clips which grip shoes as seen in photo

for the Household



NEW VACUUM CLEANER
"Power dusting" of woolens and furs with mothproofing crystals is one of the jobs performed by a new vacuum cleaner. Another novel feature is the paper dirt filter shown below, which makes it easy to empty



REFRIGERATOR HUMIDITY CHEST. Foods keep fresher and retain their natural flavor in the refrigerator compartment below, in which the humidity is automatically controlled



BATH KIT. For carrying toilet articles to and from the bathroom, this handy basket accommodates towels, toothbrush, and beauty aids



COTTON DISPENSER. Absorbent cotton now comes in a thirty-foot ribbon rolled up inside a sanitary container. In use, the cotton is pulled out through a slot and torn off against a handy cutting blade

New Enamel Resists Both Acid and Fire

DRAMATIC tests illustrate the durability of a new synthetic enamel, for indoor or outdoor use. Tables or chairs painted with it resist the action of muriatic acid, in which zinc readily dissolves. When naphtha is ignited on a painted metal surface, and allowed to burn out, soap and water easily wash off the smudge and there is no apparent change in the finish. Available in a variety of colors, the fast-drying enamel is declared easy for anyone to apply, flowing freely and leaving no brush marks. One coat is usually sufficient.



Panels painted with the new enamel survive a real acid test

Giant Auger Bores Holes for Planting Trees in Parks

PLANTING trees has been made an easier task for the park department of Los Angeles, Calif., by a curious machine that digs the holes for them in short order. Just as a carpenter's auger bites through wood, so a power-operated, spinning bit bores a vertical hole into the soil to the desired depth. Small stones and roots are no obstacle to

the whirling blade. Lest it encounter a buried pipe line, however, operators make a preliminary survey with a "radio locator" to make sure the ground is clear of any such obstruction. Carried over the area to be planted, the device produces a buzzing sound in a pair of headphones when near any underground metallic object.

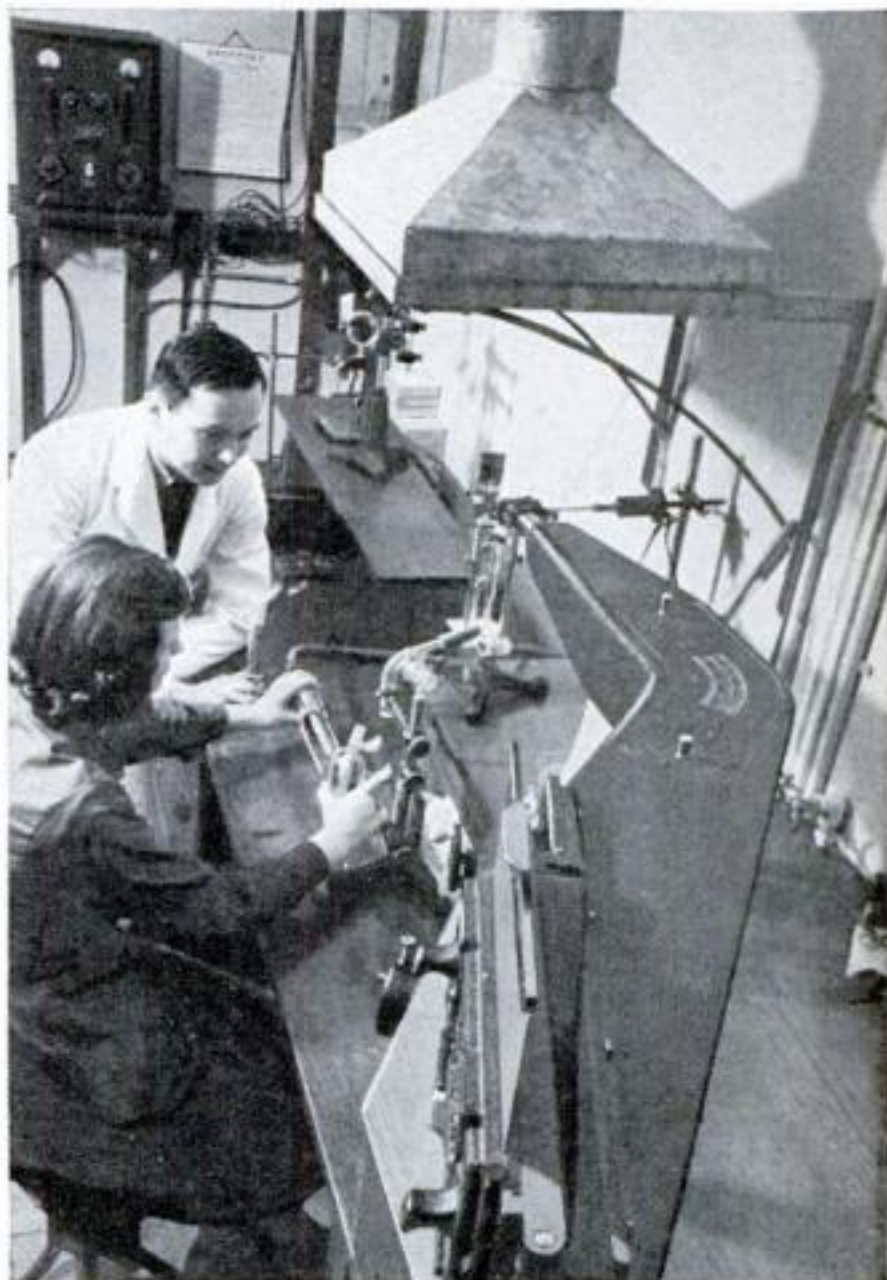


After a "radio locator" has made sure that there are no underground pipes, the drill goes into action



Spectrum photographs made with the apparatus at the right are compared with standard spectrums

Below, a sample of the soil to be tested is burned and the light of the flame is spread out for study



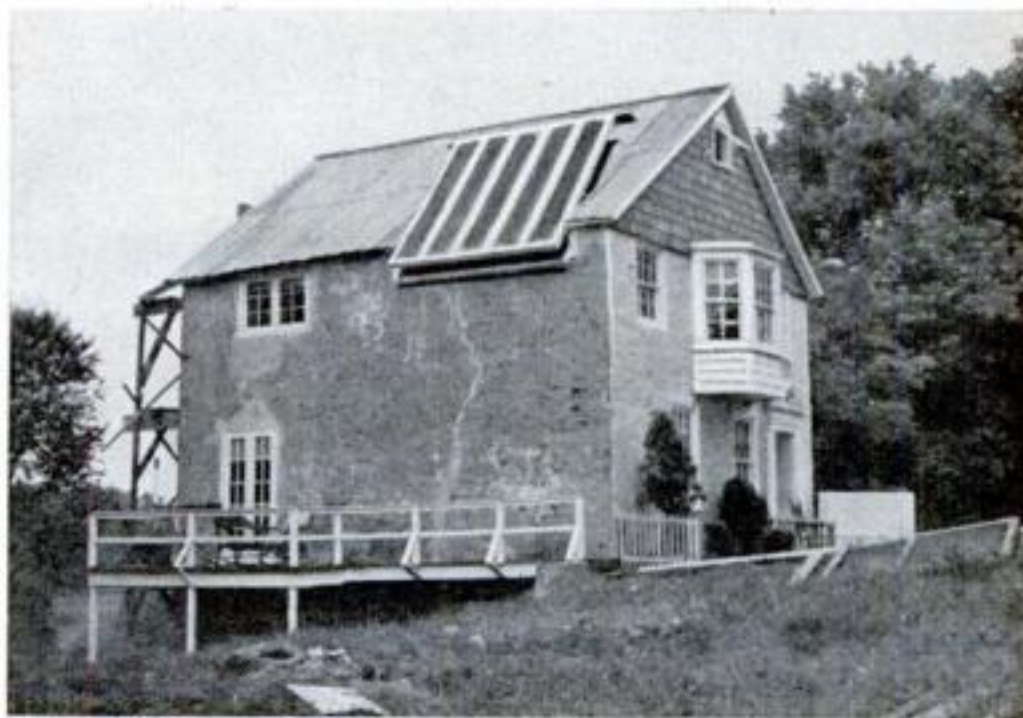
Analysis with Spectroscope Shows Elements in Soil

IN THE laboratories of the Macaulay Institute for Soil Research, in Aberdeen, Scotland, spectrosopes are now being used to analyze agricultural soils and determine the variety and amount of the elements present. A sample of the soil to be tested is burned in the flame of an acetylene torch, the light from which is spread out into a

spectrum for study. Photographs of the spectrum made from the flame in which the test soil was burned are then compared with standard spectrums that show known varieties and amounts of elements. Thus it is a simple matter to determine what elements the test sample contains, and what it lacks for growing various food products.

Skylight Harnesses Sun To Help Heat the House

MAXIMUM sunlight for winter warmth was the goal of Henry L. Ross, of Media, Pa., when he remodeled a barn for use as a dwelling. The glass skylight set at an angle into the peaked roof is perpendicular to the sun's rays at noon in mid-winter, so that a maximum of sunlight will enter rooms on the second story. The glass is of a special type that admits ultra-violet rays and is laid in two panes which are separated by a dead-air space for insulation.



Tilted to get the full benefit of the winter sun, the skylight catches heat to help warm rooms on the second floor



Harry L. Bateson with his unique strawberry-rose

Queer "Missing Link" Plant Part Rose, Part Strawberry

AFTER thirty years of experimentation and cross-breeding, Major Harry L. Bateson, horticulturist of Long Beach, Calif., has announced the re-creation of a curious "missing link" of the vegetable kingdom, a potted plant which, he believes, represents a type which existed on earth millions of years ago. According to Bateson, his product forms a link between the rose bush and the strawberry plant. Using it as a basis for development, he hopes to produce an entirely new group of fruits, vegetables, and flowers. One startling possibility he foresees is strawberries that grow on trees.

Fruit Mold Kills Bacteria

A MYSTERIOUS substance secreted by molds that form on fruit has been found to be valuable in destroying bacteria, in researches by Dr. Edwin C. White, of Johns-Hopkins Hospital, Baltimore, Md.

Try-Out Room Shows How Furniture Will Look at Home

TAKING a tip from the stage, a New York furniture store has installed a "try-out chamber" in which movable walls can be adjusted to reproduce the size and shape

of any room a customer is furnishing. Spotlights color the walls to match the actual apartment. The customer thus sees how furnishings will appear when installed.



Arranging adjustable walls in a furniture display room to duplicate the size and shape of an apartment in the customer's home. Colored spotlights, as at the right, give any tint desired

AUTOS

***How To Avoid Traffic Jitters • New
Car Faces for 1941 • Tips That Will
Help You Keep Your Car in Shape***



Do You Get



DON'TS

- 1 Don't "fight" traffic. Instead of fretting and fuming, save your nerves for more important things.
- 2 Don't drive under physical strain. Make yourself as comfortable as you can with seat adjustments and cushions.
- 3 Don't argue with other drivers. Bawling out the other fellow does no good and merely frazzles your own nerves.
- 4 Don't tolerate "bugs" in your car. A smoothly running machine is good insurance against traffic jitters.
- 5 Don't drive a noisy car. Knocks, squeaks, and rattles dull your senses and slow up your reactions in emergencies.
- 6 Don't neglect to wear glasses if you need them. Eye strain adds to general nervous strain when you are driving.
- 7 Don't drive so fast that you lose the feeling of complete control over your car. Confidence is what keeps your nerves calm.

Science takes the driver for a ride: Hooked up to instruments that record his heartbeat, blood pressure, and nerve tension, this motorist is being tested on the road for reaction to strain

IMAGINE that you are driving your car at a good clip down a boulevard running through the residential section of a city. The road is wide and uncluttered by traffic. Your car purrs along smoothly. Suddenly, with no warning whatever, a woman darts out from the sidewalk and throws herself directly into your path.

What will your reactions be? What will be the effect on your nerves? How will the shock of the experience affect your subsequent driving?

California scientists can answer these questions exactly. For recently they have been hurling bodies—stuffed dummies, of course, but drivers don't realize that at the time—in front of automobiles, as one phase of an elaborate series of road tests to determine how the hazards of automobile driving affect the nerves, and consequently the driving ability, of the average motorist.

Traffic JITTERS?

By
R. DeWITT MILLER

Their conclusions afford valuable hints on how all drivers can combat traffic jitters.

The tests, which utilize specially designed electrical apparatus, were developed by Dr. George Mount, a prominent psychologist, working in coöperation with the Union Oil Company of California. In designing the instruments to check the nervous reactions of drivers, Dr. Mount and his associates followed the principle that a person's nervous tension will be clearly indicated in three main ways: by his heartbeat, by his blood pressure, and by the electrical sensitivity of his skin—for the electrical resistance of your skin changes in direct proportion to the state of your nerves.

By means of pick-up microphones attached to wrists and chest, instruments for recording heartbeat and blood pressure were easily adapted to the problem of making continuous records while a driver was actually operating a car under traffic conditions. The development of a method of recording changes in skin resistance, however, required months of research before an acceptable solution was found.

Electrodes are attached to the driver's hands. Between the electrodes and the skin, a special saline jelly is used to insure a good contact. From the electrodes wires lead to recording instruments resting on the rear seat of the car. By means of a pointer and dial, the driver's skin resistance to low-amperage currents can be determined at any instant. Thus, this

DECEMBER, 1940

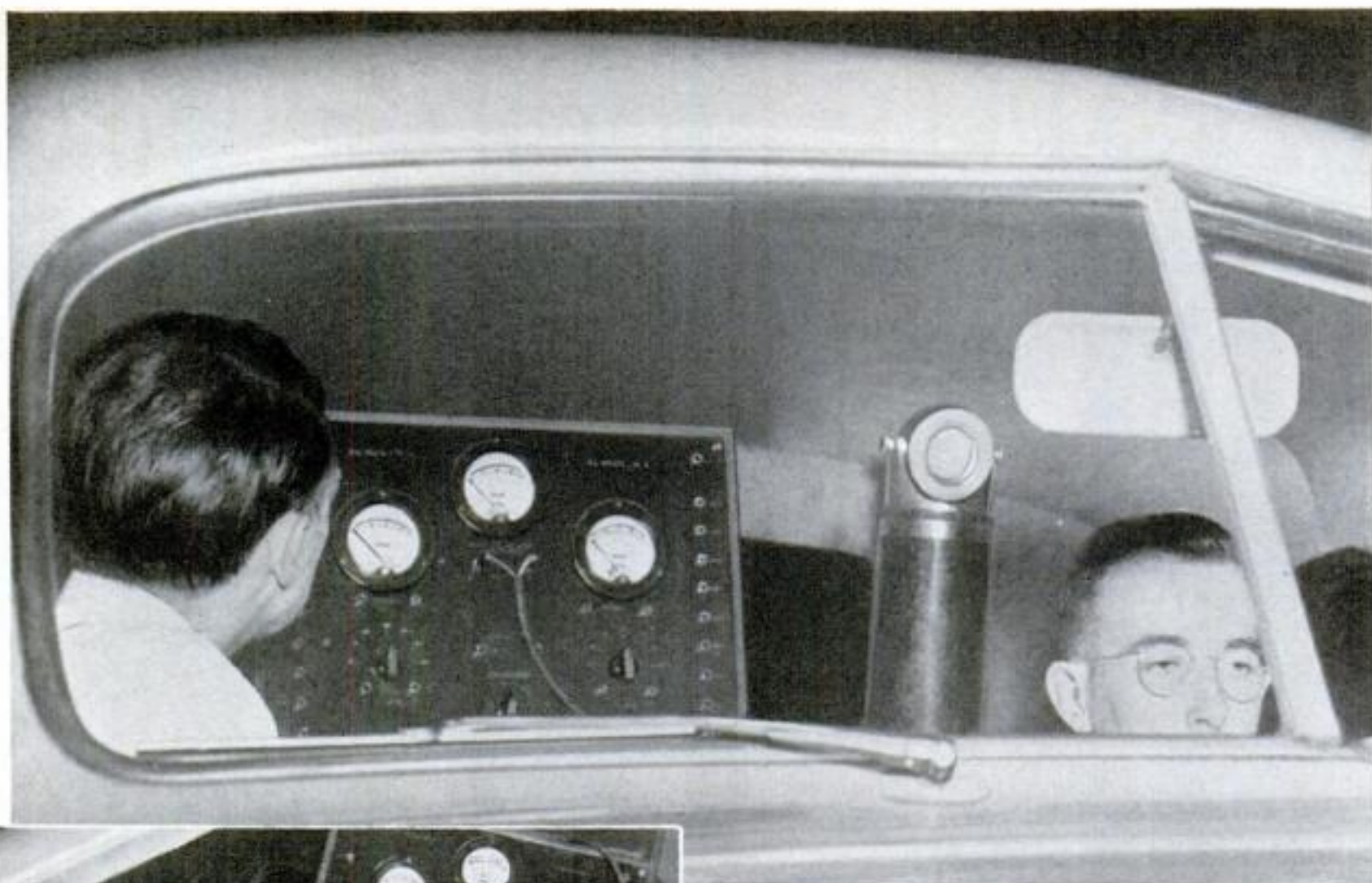


Blissfully unconscious of what lies ahead, the guinea-pig driver spins merrily along on a boulevard nearly empty of traffic

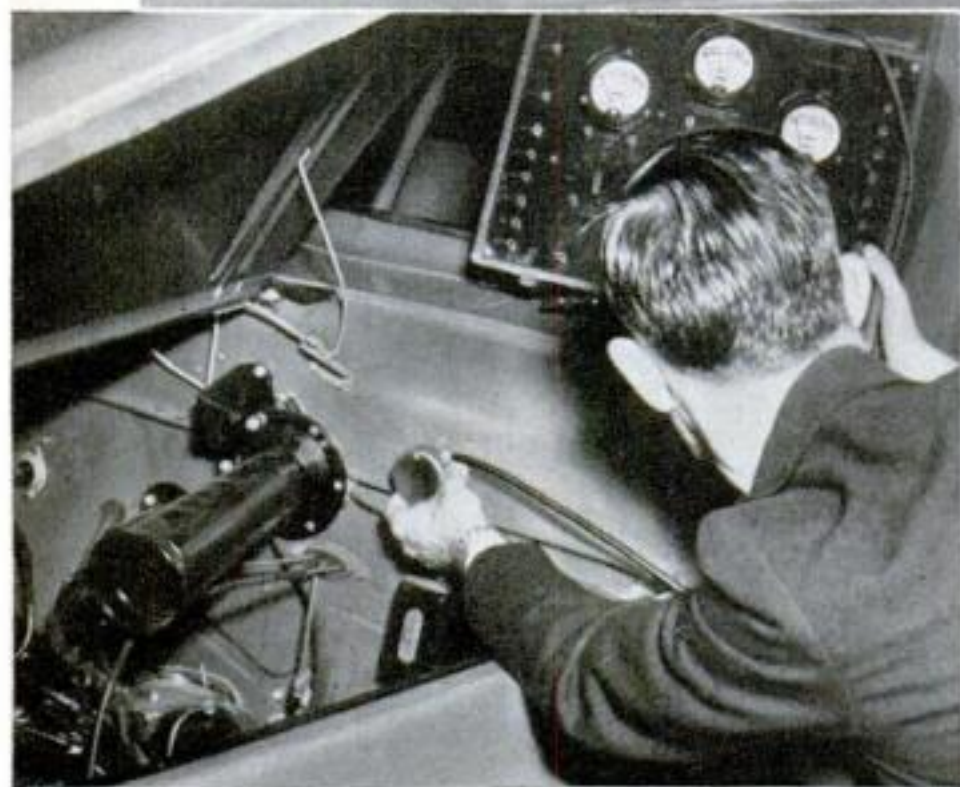


. . . when suddenly, from behind a tree, a "body" hurtles through the air into the path of the speeding car. Note the driver's expression below. Meanwhile, the instruments keep on recording





Car noise was found to be an important factor in traffic jitters. Above, an instrument counts decibels at the driver's side



Another method of checking up on noise is to pick up vibrations of the engine bulkhead, as illustrated here



Inside view of a portable instrument which writes a continuous record of the action of a subject's heart

apparatus, together with the heartbeat and blood-pressure instruments, writes a running story of the nerve responses of the driver as he meets the numerous problems of traffic in congested areas.

When hundreds of subjects had been tested on the road with this equipment, the California scientists discovered that there are two distinct types of nervous strain brought on by traffic driving: steady strain, and shock strain.

Steady strain is the general nervousness that accumulates during difficult driving, regardless of whether the motorist encounters any emergencies during the trip. In thirty minutes of traffic driving, the nervousness of the average motorist, the psychologists determined, is increased twelve percent by this steady strain.

Naturally, steady strain will be further increased by shock strain, the type that occurs when a driver just misses a jaywalker, can't stop for a suddenly changed traffic signal, realizes that his brakes have failed, or is confronted with a similar emergency. Shock strain, it was found, will increase a driver's nervousness by as much as twenty-seven percent in a half hour of traffic driving.

Twenty-seven percent seems a tremendous jump, but the scientists point out that one close call in traffic will speed a driver's heart action as much as

twenty-five beats a minute. At the same time, the resistance of the skin to electrical currents makes a similar change, blood pressure skyrockets, and muscles become tense. Incidentally, it is interesting to note that women proved to be thirty percent more nervous than men after similar traffic-test drives. In general, Dr. Mount states, women are less affected by steady strain and more by shock strain than men.

FROM these traffic tests the scientists also discovered what they term a short-circuit reaction. This occurs when a driver responds automatically to a traffic problem, without any conscious thought about it. Certain of these short-circuit reactions can become dangerous. If a driver applies his brakes in any and every emergency, he will eventually form a short-circuit reaction by which he will automatically brake without conscious thought of what he is doing. Then one day an emergency will arise when applying the brakes would be the worst possible action to take—during a skid on a wet pavement, for example.

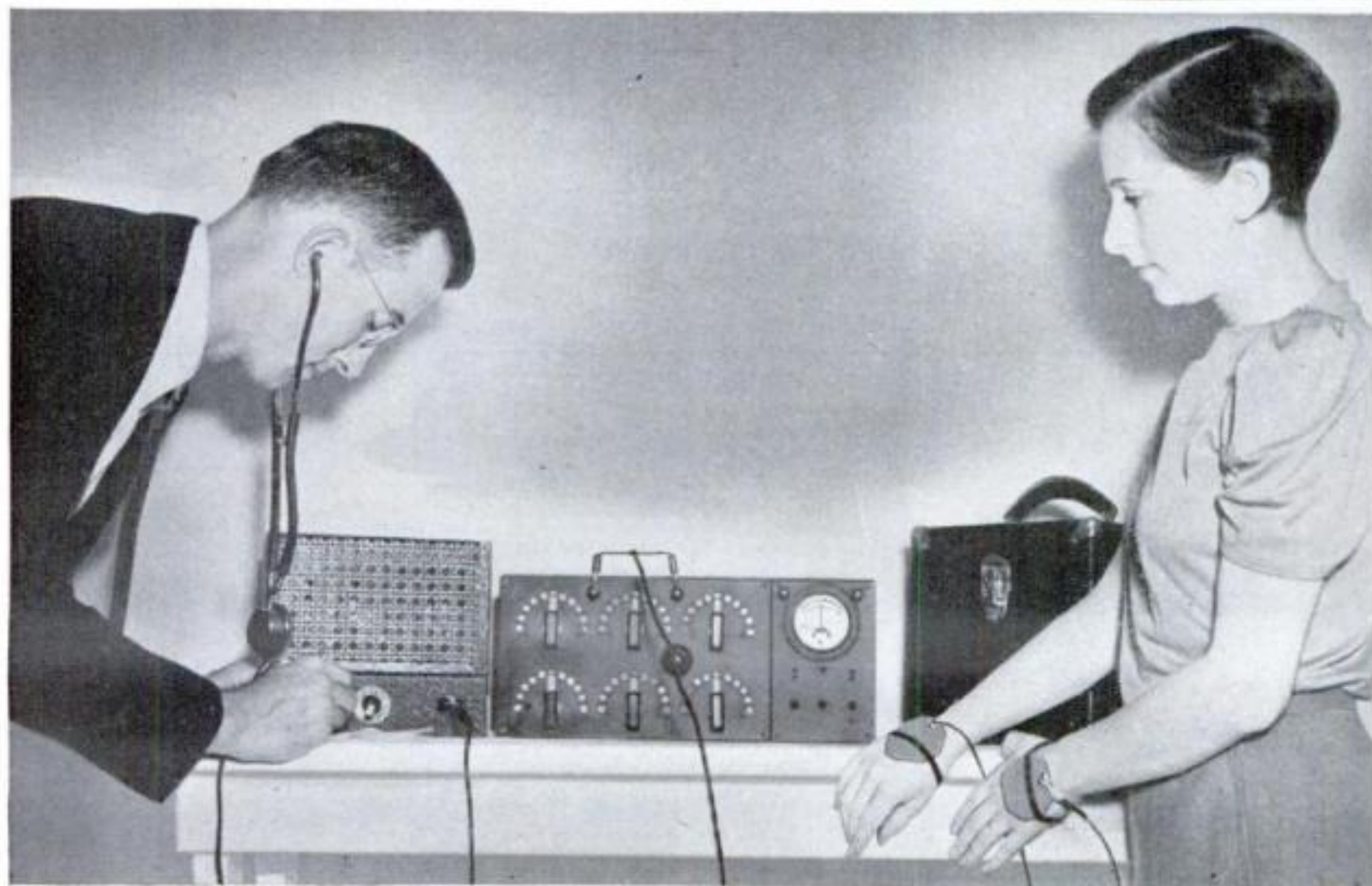
To prevent this, the scientists suggest that all drivers look out for the first indications of any type of short-circuit nerve reaction, and then combat it before it gains headway. This

can be done, they state, simply by occasionally forcing yourself to think *why* you stop or accelerate your car in a given situation, before you actually do it.

Noise is another element that has a bearing on traffic nerves, the investigators found. By spotting sensitive microphones to record the sound volume inside of several cars, and then having subjects drive the cars while their reactions were checked, the scientists discovered that car sounds definitely affect driving ability.

But, strangely enough, the effect of car noise on a driver is to decrease the efficiency, not of his sense of hearing, but of his senses of sight and smell, and his speed of nerve reaction. This agrees with the psychological principle that when one sense is overstimulated, the other senses are dulled.

A microphone placed over the driver's heart picks up the heartbeat, while electrodes on wrists help determine electrical resistance of the skin, as demonstrated in the experiment below

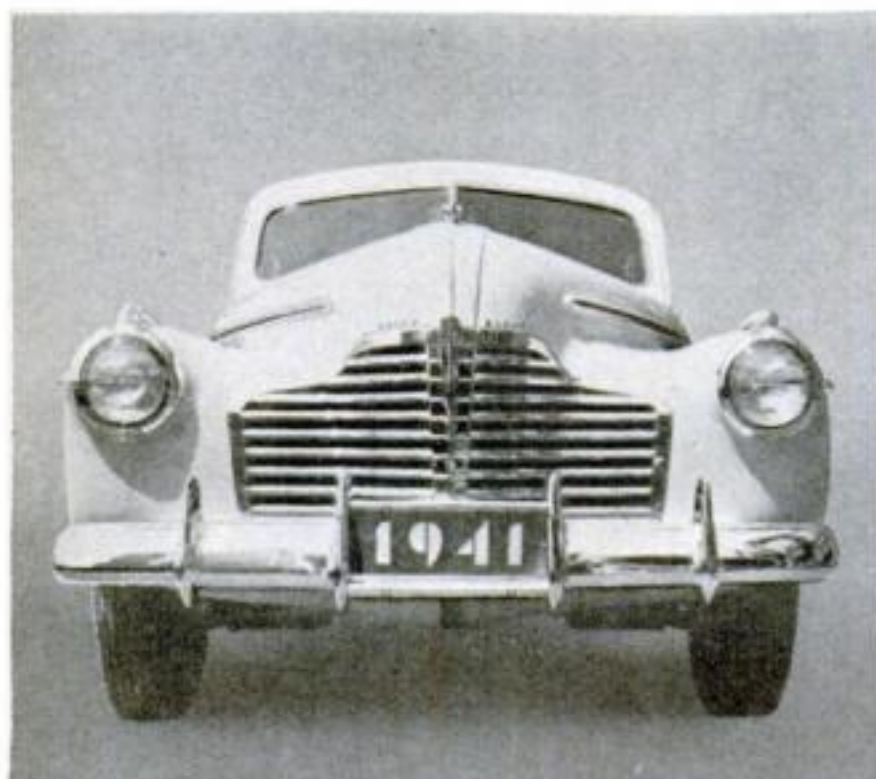


NEW CAR FACES FOR 1941

WHETHER it's body styling, engineering refinements, ingenious accessories, or any or all of these, there is something brand new in every car, every year. That 1941 is no exception is apparent, and the explanation is written on the faces of the new cars presented alphabetically on this and the following pages.

Outstanding body-design features on the new cars are concealed running boards, wider radiator grilles, and heavier bumpers. The fenders mostly have flatter tops, while

several have nearly perpendicular skirts dipping low and adding to the feeling of solidness. On several cars, the more gracefully curved hoods are lower for increased visibility, and wider where they fair into the windshields to conform to the generally increased width of the bodies and seats. Tops are lower, while headlights are in most cases spaced farther apart. And built into these cars are factors of safety, comfort, economy, durability, and driving ease to please the most critical tastes of America's motorists.



BUICK. Redesigned piston heads, higher compression, and two dual carburetors step up the power in the new, more massive and streamline Buicks



CADILLAC boasts a 150-horsepower motor in each of its six lines, and invades the medium-price market. It has an optional economy rear-axle ratio



CHEVROLET wheelbase and body are longer; body is lower and more massive. Concealed steps replace running boards; headlights blend into fenders



CHRYSLER. Fluid drive is available on both the sixes and eights, with a high-gear improvement. The front-end design stresses horizontal lines



DE SOTO, at 105 horsepower, also offers fluid drive, as do Dodge and Chrysler. Fender tops are flattened and made in one piece with hood sides



DODGE. Flowing curves sweep up from the base of the radiator grille, reaching all the way to the headlamps. (Bumper attachments shown are extras.)



FORD front ends show new fender treatment, and radiator grilles are recessed somewhat into the metal. The new bodies are both wider and longer



GRAHAM offers four lines, starting in the medium-price field, many available with superchargers. The Hollywood shown has exceptionally low floor



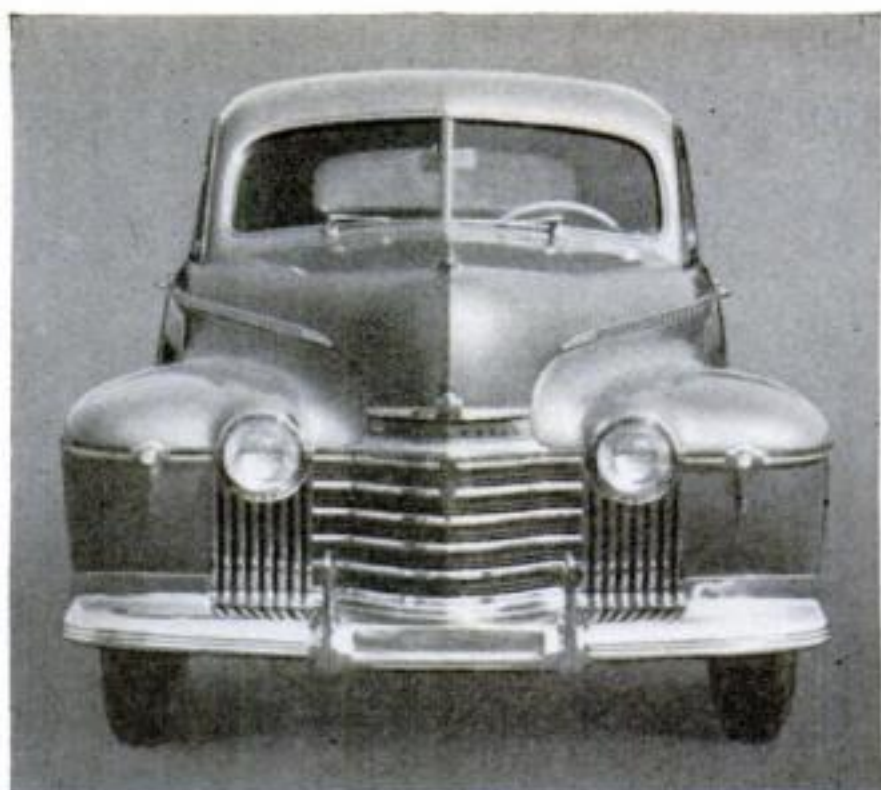
HUDSON. Symphonic styling—meaning harmonious two-tone colors inside and out—is stressed by Hudson, along with its brand-new transmission



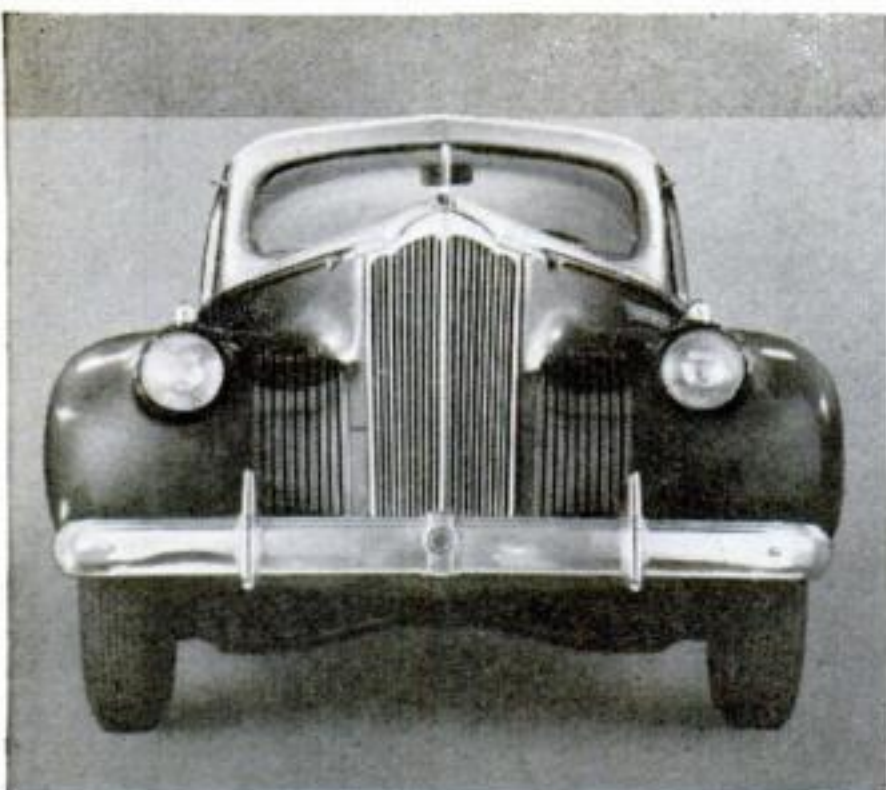
MERCURY, roomy, powerful medium-price line of Ford-made cars, offers numerous engine and chassis refinements, with lower, wider bodies



NASH enters the low-price field with an all-new car slung on coil springs at all four wheels, and having chassis and body welded as a single unit



OLDSMOBILE has six lines—three sixes and three eights—with strong family resemblances. New bumpers protect the front and rear fender skirts



PACKARD offers sixes, eights, and super eights with striking innovations in all lines. The familiar radiator outline still distinguishes it



PLYMOUTH, more powerful, has a new grille design. A new second gear is used for most starting, and a vacuum-power gearshift is available if desired

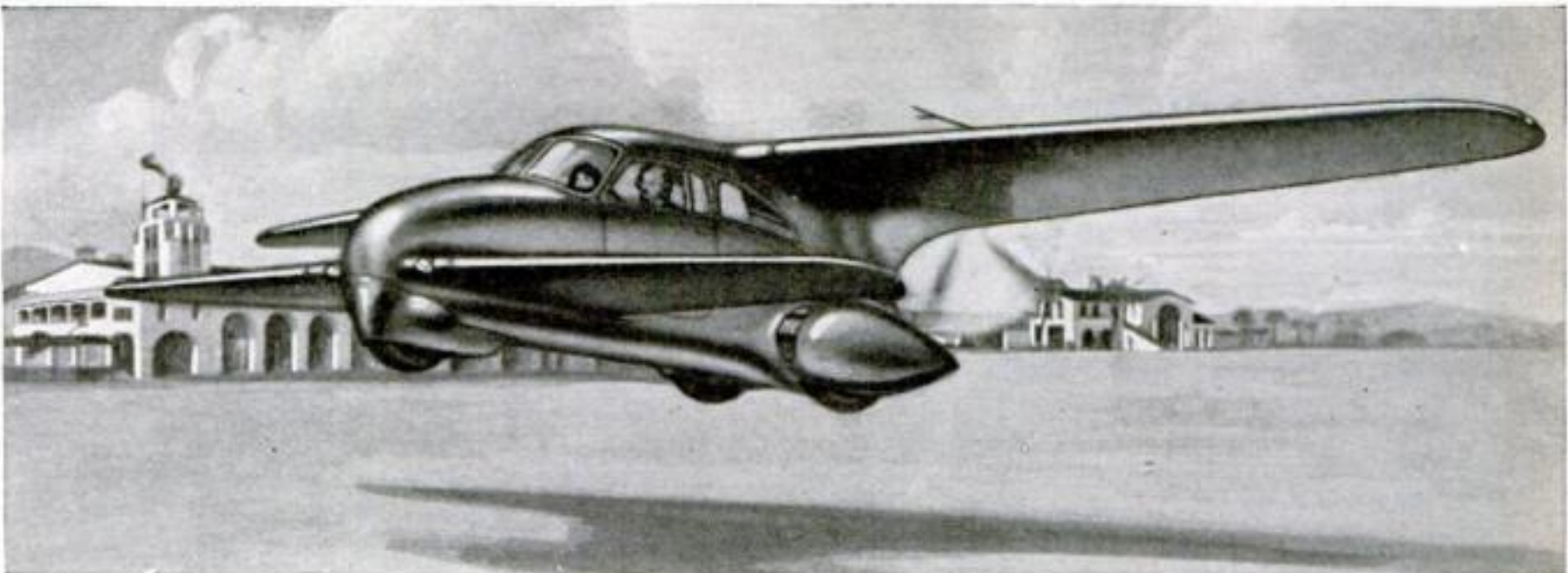


PONTIAC. Three separate torpedo lines, with many models in each, are available with either six or eight-cylinder engines. Appointments are restyled

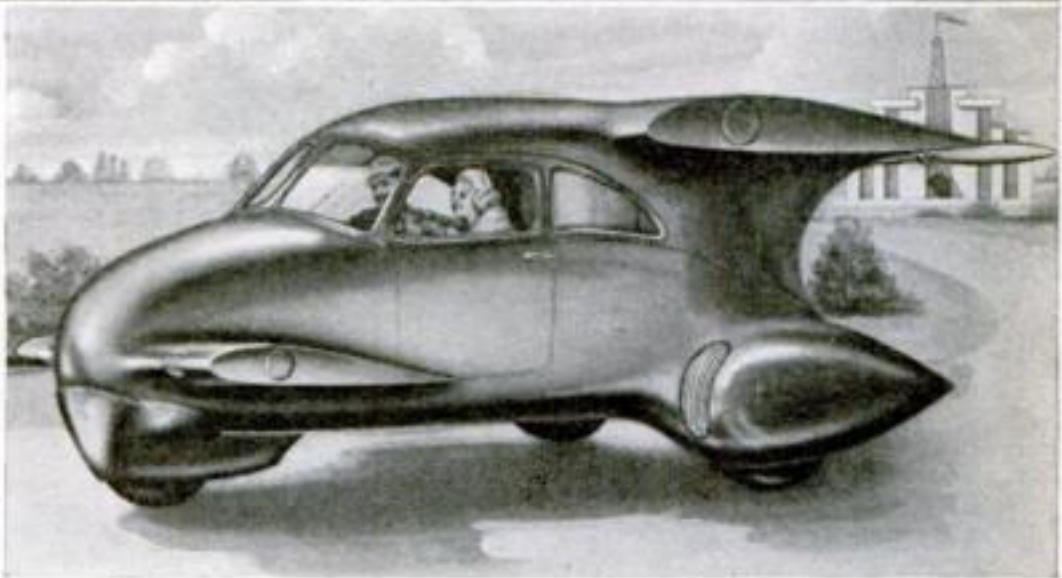


STUDEBAKER in all models of its three lines is roomier, more eye-striking, and responsive to the accelerator; also offers a torpedo-type car

Detachable Wings Turn Three-Wheeled Car into a Plane



A HYBRID land-and-air machine, with wings that can be shed on landing, is proposed for quantity production by a Dayton, Ohio inventor and manufacturer. The machine, called by its designer an "Aerobile," is said to have passed wind-tunnel experiments although no actual flying tests have been attempted. The body of the craft forms a three-wheel torpedo-shaped car for road driving after the wings have been removed. The machine is driven by a pusher propeller when it takes to the air.



The combination automobile-airplane on the road. In the upper picture, it is taking off as a plane with its detachable wings in place and a pusher propeller

Headlight Chart Shows Safe Speeds for Night Driving

SAFETY charts for night driving have been worked out, as the result of hundreds of tests, by W. W. Harper, nationally known traffic expert of the Pasadena, Calif., Police Department. The charts give the safe speeds under different driving conditions.

Placed on the instrument panel of the car in front of the steering wheel, the chart can be consulted at the beginning of a trip. After a few days, the safe speeds will be memorized and reference to the chart will not be necessary any longer.

NIGHT DRIVING CHART • MAXIMUM SAFE SPEEDS •									
ROAD SURFACE	LOW BEAM LIGHTS				HIGH BEAM LIGHTS				
	SENSE FOR	LIGHT FOR OR RAIN	CLEAR AVERAGE	LIGHTED HIGHWAY	SENSE FOR	LIGHT FOR OR RAIN	CLEAR AVERAGE	LIGHTED HIGHWAY	
VERY DRY			35 ¹⁷	40 ²⁰			40	45	
AVERAGE OR MOIST	12 ⁵	25 ¹²	30 ¹⁵	35 ¹⁷	18	30	35	40	
WET OR MUDDY	10 ⁵	15 ⁷	20 ¹⁰	25 ¹²	15	20	25	30	
ICE	5	10 ⁵	12 ⁶	12 ⁶	7	10	15	15	

ASSUMPTIONS: 1. MAXIMUM ATTENTIVENESS OF DRIVER 2. GOOD LIGHTS 3. GOOD BRAKES
4. NORMAL STREETLIGHT 5. STREET OR HIGHWAY WITH NO GRADE

EXAMPLE: USING LOW BEAM LIGHTS, ON A CLEAR NIGHT, AND DRIVING ON A WET PAVEMENT
MAXIMUM SAFE SPEED IS 20 MI/HR OR 10 MI/HR IN A BUSINESS DISTRICT

NOTE: IF DRIVER IS UNCERTAIN ABOUT ONE OR MORE ASSUMPTIONS GIVEN ABOVE,
USE CORRESPONDINGLY LESS SPEED UNDER ALL CONDITIONS

WARNINGS: 1. HEADLIGHTS AND STREET LIGHTS ARE NO SUBSTITUTES FOR DAYLIGHT
2. HAVE YOUR SPEEDOMETER CHECKED
3. DO NOT CONSULT THIS CHART WHILE DRIVING - STOP FIRST!

Prepared By: W.W. Harper - Pasadena, Police



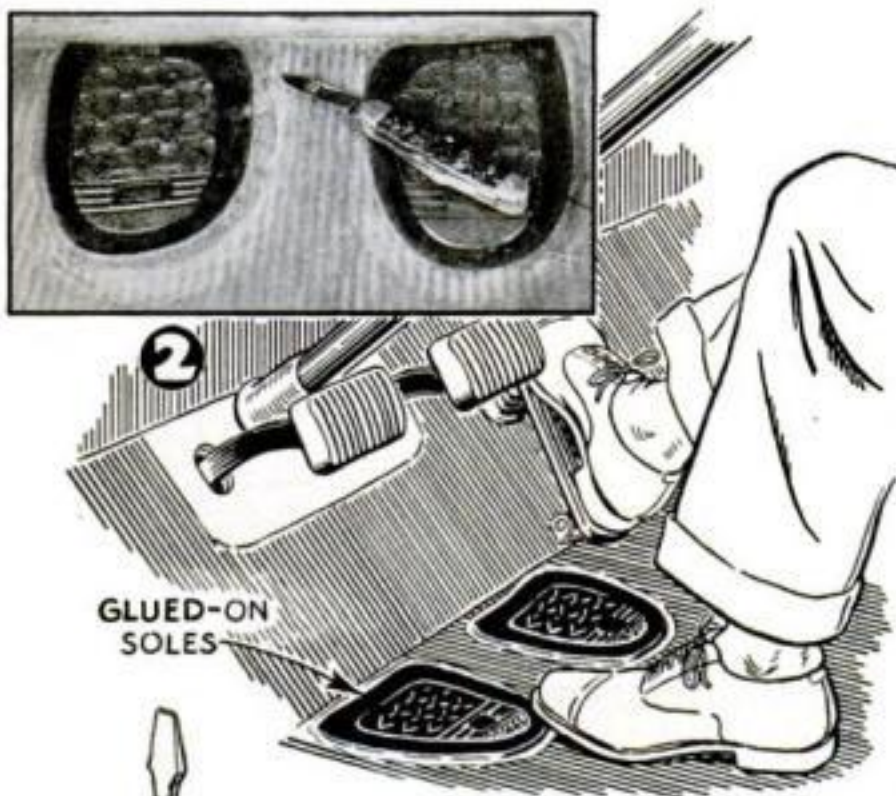
How fast should you drive at night? This chart, placed on the dash as shown, tells you at a glance

PRACTICAL HINTS



1 AS A SAFETY FACTOR for winter driving, as well as a convenience, an electric defroster fan mounted on the deck space behind the rear seat of a car and aimed at the rear window is as effective as one used on the windshield. It keeps fog and frost from forming on the inside, and melts snow and sleet that gathers on the outside while parked or driving. It may be easily wired from the ammeter and ground through a dashboard switch.—W. P. H.

2 FLOOR-MAT PROTECTORS consisting of a pair of five-and-dime-store shoe soles of the stick-on variety are easy to attach underneath the brake and clutch pedals of your car. They are usually available with a supply of glue and a scraper, and will protect the floor mat from the scuffing of your heels.—A. O. S.



3 A HANDY WRENCH for loosening or tightening the terminal nuts found on most spark plugs can be made by simply drilling a hole slightly smaller than the outside diameter of the nuts in the handle end of a screw driver. The hard wood wrench will loosen tight nuts without damage.—W. C. W.

4 TROUBLE LAMPS mounted under the hood and connected to a dashboard switch are a boon when you have engine trouble on country or unlighted roads at night. I purchased two old cowl lamps and fittings from a junk dealer and connected them as shown. In some cars it may be found easier to attach them directly to the fire wall or the radiator tie rods.—E. F., Jr.



HOLE, $\frac{3}{8}$ " DEEP, SERVES AS SOCKET WRENCH FOR SPARK-PLUG TERMINALS



FOR CAR OWNERS

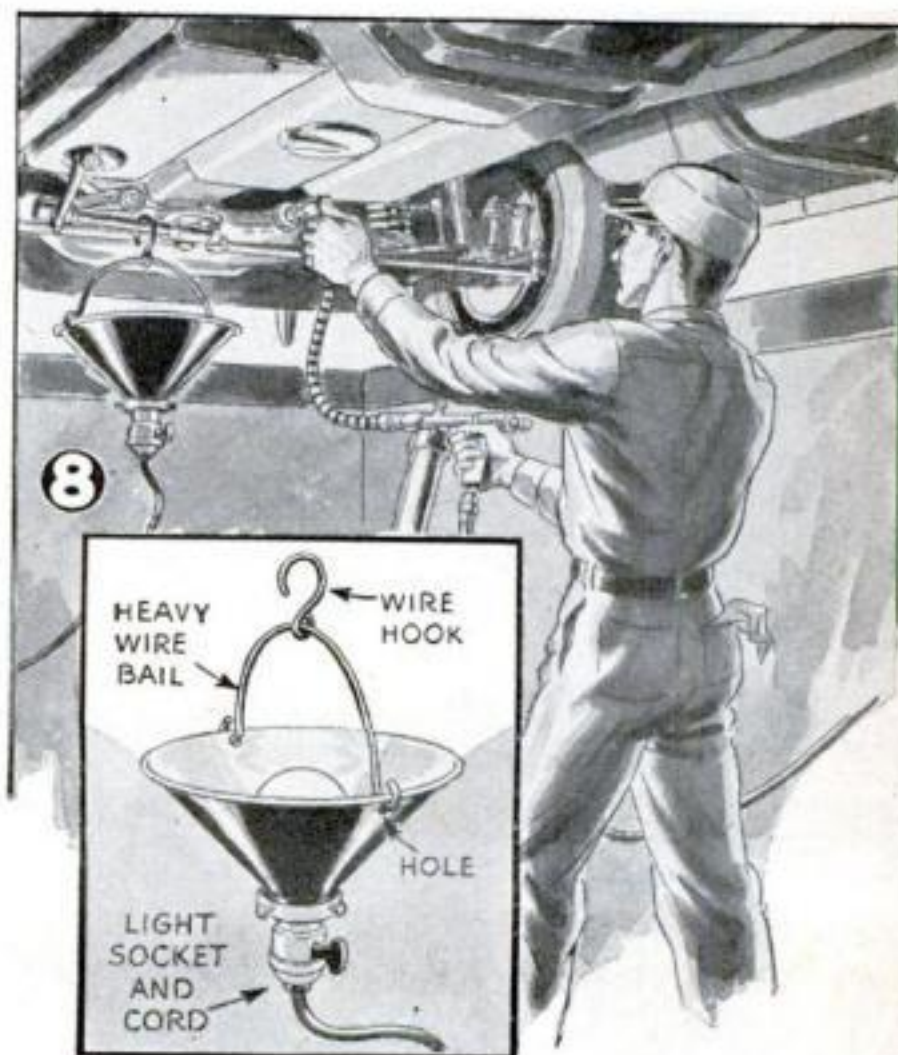
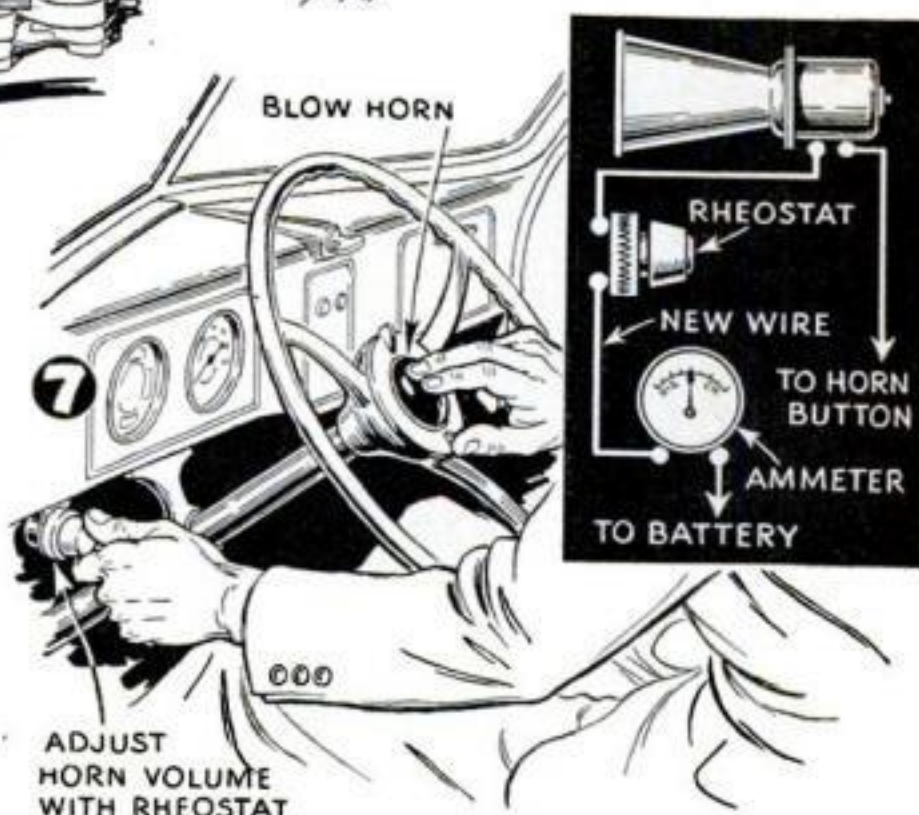


5 A FAN-SHAPED SPRAY of water for washing cars is obtained without the necessity of holding a thumb over the end of a hose by means of an inexpensive device. This consists of a ten-cent hose coupling, with the inner sleeve squeezed flat in a vise. The coupling is then screwed on the end of the hose like a nozzle when needed to deliver a strong, rinsing stream of water to the work.—E. M.

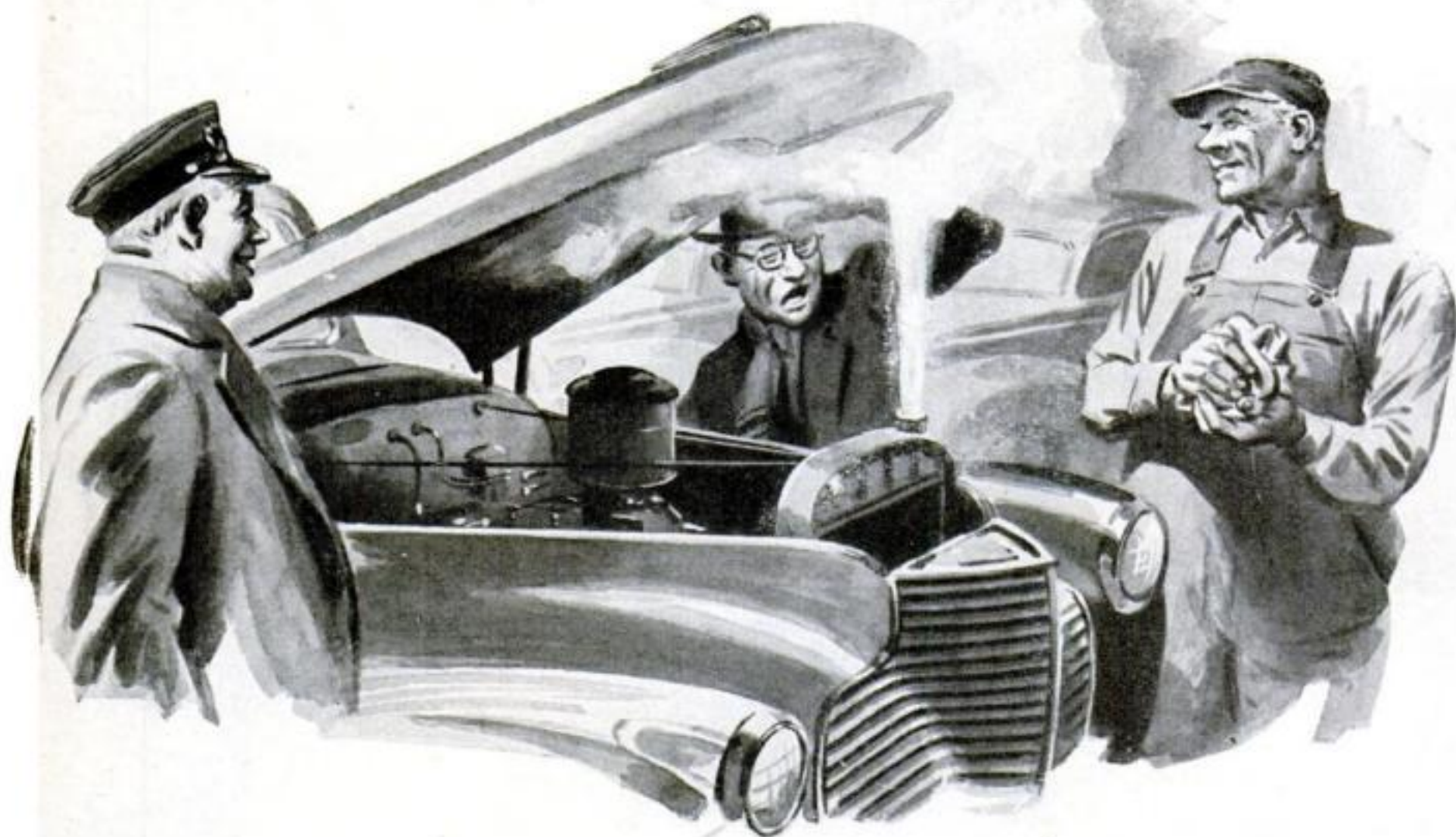
6 QUICKLY SHOWING THE OIL LEVEL, a white-enameled measuring rod or dip stick is much easier to read, even if the oil is cloudy from long use. The rod should first be cleaned and then given two coats of high-quality enamel. Brush the enamel only up to the "full" mark so that you can still tell when your crankcase is filled.—E. H.

7 TONING DOWN YOUR HORN for city driving is possible on many cars by placing a rheostat in the horn circuit and mounting it on a convenient spot under the dash. If the horn operates through a relay, be sure and connect the rheostat into the relay circuit, not into that of the horn button.—P. M.

8 FREEDOM FROM GLARE while working beneath a car in a greasing pit or under a car hoist at night is obtained by replacing the unshielded wire guard of your trouble lamp with a metal cone as shown. With a little ingenuity, you can rig up the outfit with a piece of sheet iron, a length of wire, and a hook shaped as in the sketch for attaching the device to the underside of a car wherever it is needed.—L. B. R.



"You fellers have cheated me!" old Silas yelped. "My radiator all froze up—busted, likely!"



GUS Gets Ready for Winter

S NOW sweepers swished on the road outside as Gus Wilson shed his ulster in the shop of the Model Garage on the first real winter morning of the cold-weather season. A heavy fall of the white stuff early the evening before had been followed by the mercury taking a nose dive, and now at eight o'clock of a sunny, windy morning the thermometer outside the office door registered only ten above zero.

Gus's partner, Joe Clark, was grinning a good morning from the office door. "You'll have a bad case of telephone ear by nine o'clock," Gus told him. "All the customers who as usual didn't remember to take the precautions we advised will be phoning us to get their frozen-up busses started. It's always that way the first real cold morning of the winter."

"Sure is," Joe agreed. "It's hard on the ears, and it makes you wonder why the Lord made so many people downright careless, but it's good for our business. Remember that morning when—"

He was interrupted by the honking of a horn outside the shop doors. Then someone

shouted "Hey, you, Gus Wilson—open up! It's colder'n heck out here!"

"That's Ez Zacharias," Gus said as he unlocked the double doors. "I didn't expect he'd be the first one to holler for help. Usually he's a pretty wise bird when it comes to keeping out of avoidable car trouble."

Ez usually covers his R.F.D. route in a smart-looking sedan, but this fall he invested in a light truck, three or four years old but in A-1 condition, for use when the dirt roads back in the country get bad or, around the holidays, when he has especially heavy parcel-post deliveries to handle.

He drove this truck into the shop, leaned from the seat, and scored a V on Gus's waste box with an active-service charge of tobacco juice. "By gum," he said, "the feller who sold me this darn truck took me fer a sucker, and he didn't make no mistake!" He climbed out, pushed his postman's cap away back on his shaggy head, and shook a big and hairy fist at the vehicle. "First time I ever seed a automobile that'd run ahead smooth as velvet, but wouldn't

back up without goin' dead. Took me a good ten minutes to get backed out of my ga-rage, by hookey! Every danged time I put her into reverse she'd die down, start up again, hit a few times, and then quit like a yaller dawg on me! Take a look at her, will you, Gus?"

Gus got into the truck, stepped on the starter, and shifted into reverse. The truck ran smoothly over the shop floor, but the moment its rear wheels hit the snow-covered driveway outside, the engine sputtered, and then went dead. When he stepped on the starter again and shifted into low, the truck ran back into the shop without a miss.

"That's a new one on me," he said. "First time I've ever known a car to act like that."

Gus checked the points and condenser and found them in excellent condition. When he restarted the engine it ran smoothly. He again backed the car out of the shop. As soon as its rear wheels were on the snow-covered driveway he noticed that there was a lot of vibration—so much that he could feel the engine moving back and forth on its rubber mountings. As soon as he shifted into low speed the vibration ceased and the truck ran smoothly back into the shop.

When he raised the hood his eyes still were so badly dazzled by the glare of the bright sun on the newly-fallen snow that he could scarcely see the engine. That was why he noticed the faint flicker of a spark where the wire entered the condenser. When his sight returned to normal he saw that one of the strands of the wire had frayed loose, and that its ragged end was close to the condenser.

He examined the truck's rear end, and nodded when he saw that its spring suspension was like that used on some old-model passenger cars—a half conventional spring, with one of its ends connected to the frame and the other to the rear axle. Without further checking he replaced the frayed wire with a new one. "All ready to roll," he told Ez as he lowered the hood.

"Yeah?" the postman said. "What the heck was the matter with her?"

"A strand of frayed wire was hitting against the condenser and shorting your engine," Gus told him.

"What? That don't make sense," Ez object-

The Boss of the Model Garage Tells You How To Avoid Being Chased off the Road by That Old Man Zero Weather

By MARTIN BUNN

ed. "The engine ran swell except when she was in reverse."

"That's what fooled me," Gus said. "The answer is that, with this particular type of spring suspension, the wheel pulling backward in the snow cause a sort of bouncing motion. That motion makes the engine rock on its mountings, and that rocking brought the end of the frayed wire in-

to contact with the condenser and caused the short that killed your engine whenever you went into reverse in the snow. Get it?"

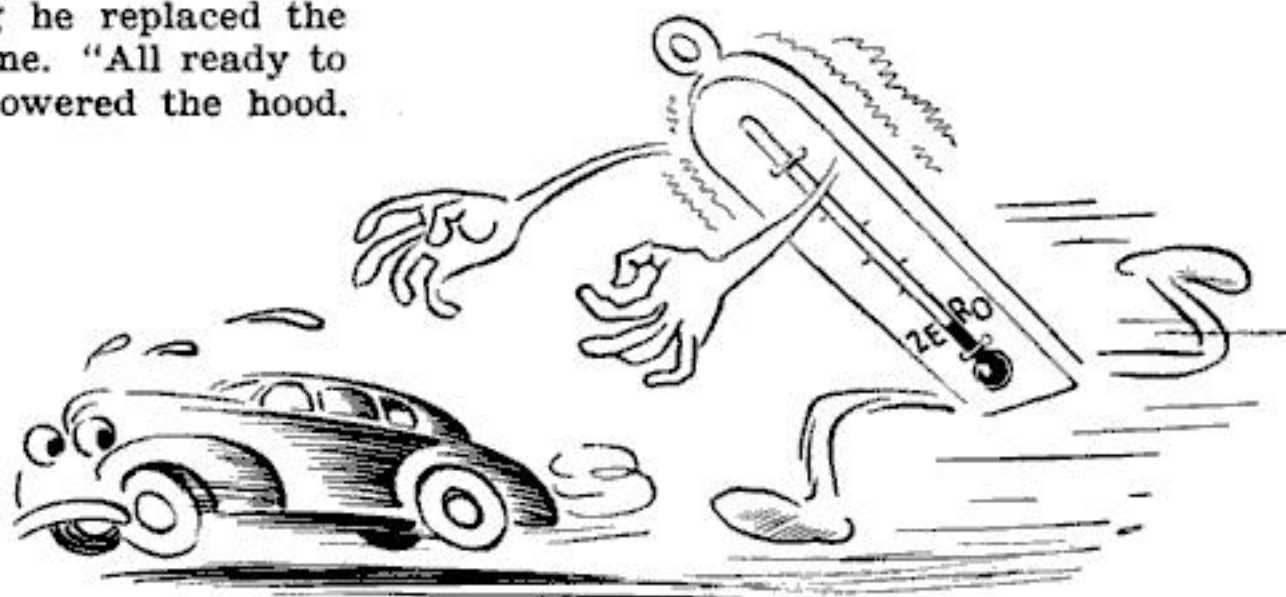
"I guess I do," Ez said doubtfully, and bit off a modest inch of coal-black plug. "Well, I better be gettin' along an'—hey, there's some guy who's in a real hurry!"

It certainly sounded that way. From outside came repeated squawks of a raucous horn. "Let him in, Harry," Gus directed the grease monkey. "If you don't, he'll knock our doors down."

Harry opened the doors. He had to step lively to get out of the way of a sedan which shot into the shop and came to a jarring stop. Out of it leaped old Silas Barnstable, looking even more like a bantam rooster than usual in the ancient seal-skin driving cap he was wearing. "Do something quick!" the little retired farmer squealed. "My motor's red hot and my radiator's b'ilin' over!"

Gus raised the hood and cautiously unscrewed the radiator cap, releasing a cloud of steam. "All right—you can switch off your engine," he told Barnstable. "You ran it close, all right! I'll bet there isn't more than a cupful of water left in your cooling system."

"You fellers have cheated me!" old Silas yelped. "That Joe Clark told me I ought to fill up my car with a lot of high-priced antifreeze, an' I was fool enough to do it."



Now look what happens, the first cold day we have! My radiator all froze up—busted, likely!"

"No, your radiator isn't frozen, and it isn't busted," Gus reassured him. "But your hose is leaking so badly that your cooling system is darned near dry."

Ez Zacharias began to laugh—and when big Ez laughs the walls shake. "Tell the whole story, Mr. Barnstable!" he scoffed. "I was in here when Joe Clark argued you into buying that antifreeze, and I heard him warn you that your hose was so rotten that you'd probably lose most of it. That's my idea of cock-eyed economy—wasting pretty near five dollars' worth of anti-freeze to save a quarter for a new hose!"

Old Silas glared at Ez and turned to Gus. "I'm depending on you to do the square thing about this," he wheedled. "I ain't had any use out of that antifreeze, so it would be only fair for you to replace it without charging me anything. But I ain't asking you to do that—make it half price for the new antifreeze, and fill her up."

Gus laughed. "No smoke, Mr. Barnstable," he said good-naturedly but very firmly. "Joe warned you that your hose was rotten. You didn't take his advice to put in new ones, so you'll have to stand the loss. I'll install new hose and put in a fresh filling of antifreeze if you want me to, but you'll find both items charged on your bill at our regular prices."

"You're the hardest man to do business with I've ever run up against in all my born days," Silas growled. "No give-and-take spirit at all. All right—have it your way. I'll be back for my car this afternoon!"

"Serves the old skinflint right," Ez observed after Silas had left. "He's so mean he—"

"He can't help being a penny-pincher. He was born that way," Gus said. "And, after all, the grief he gets into by being so tight is pretty much the same as the grief that a lot of other car owners bring down on themselves through plain carelessness. He's not the only man in this town who makes his winter driving hard instead of easy."

Ez settled himself comfortably on the end of Gus's workbench. "How come?" he wanted to know.

"The first thing you've got to have to

make winter driving easy," Gus explained, "is a cooling system that is tight as a drum. Antifreeze, no matter what brand of it you use, costs money, and there's no sense in pouring it into your radiator and then allowing it to leak out. That's bone-headed waste. And besides that it is mighty likely to result in serious damage to your engine. Before cold weather starts you should have your cooling system checked to make certain that your radiator doesn't leak, that your hoses are good and their connections tight, that the cylinder-head gasket is tight, and that your pump shaft is tightly packed.

"After you have made sure that your cooling system is tight, you should make just as sure that your radiator is clean—that it isn't clogged or half-clogged with rust, sludge, scale, or sediment. You can do that by flushing it out with a ten-cent can of the same sort of prepared noncaustic powder

that's sold for keeping bathroom drains clear—you can buy it in any grocery store and in most garages. Run your engine until the water in the system is warm. Then pour the powder into the radiator, and run your engine for another fifteen minutes. Then drain the radiator, and flush it out once with warm water. Less than a half-hour's job—and when you have done it you know that your radiator is clean."

"I've heard a lot of arguments about anti-freeze mixtures," Ez observed. "What's the best one, Gus?"

"So far as I know there isn't any best one," Gus said. "That's why we sell several of 'em. The more expensive ones are made of about ninety-seven percent ethylene glycol, with added ingredients which protect the cooling system against rust and corrosion. They don't evaporate or boil away, and you can drain them out of your radiator in the spring, allow the dirt to settle out of them during the summer, and then use them again the next winter.

"If your cooling system is tight, and you use the proportion of antifreeze to water recommended by the manufacturer, it will give your car absolute protection. Only the water in the radiator will evaporate, and if all your winter driving is short trips, so little of the water will evaporate that it won't need to be added to until spring. It's a good idea (*Continued on page 237*)

GUS SAYS:

The drivers who put off getting their cars ready for winter are the ones who help me pay my income tax, so I really shouldn't kick. But I hate to see good machinery ruined, and nothing will ruin an engine block like ice. Get busy and check up on your antifreeze!

HOME *and* WORKSHOP

*Heating at Lower Cost • Wall Units
Modernize a Room • Arc Soldering*

See Page
186



Saving Money on

**ARE YOU STOKING THE FURNACE WITH DOLLAR BILLS?
HERE ARE SIMPLE WAYS TO SLASH YOUR FUEL COSTS**

By IRA KUCHLER

Consulting Architect

DID last year's fuel bill upset your budget? Unnecessary heat losses in the heating system may have been responsible, and a few minor repairs or changes will perhaps result in reducing the heating costs considerably.

Start with a factor common to all steam and hot-water systems—the paint on the radiators. If the paint is aluminum or gold bronze, the radiator is losing upwards of five percent of its radiated heat by reflection back into the metal. Several coats of a good eggshell or flat-finish linseed-oil paint, chosen to harmonize with the room and applied thin to a warm radiator, will straightway knock a bit out of your fuel costs. It isn't necessary to remove the old finish.

If the radiator covers are badly designed, closing in the heat beneath them, they may waste as much as thirty percent of the heat.

Well-designed covers permit a free circulation of heated air.

For efficient radiation, all air valves on radiators must function properly. If the small hole in the cap is clogged up, a pin will open it. If the valve doesn't work even when clean, yet there is good steam pressure, try turning it to a 45-deg. angle or even upside down. If this fails, the valve should be removed and soaked in gasoline or boiling vinegar.

Are your boiler and cellar piping sufficiently insulated, or are you burning up extra fuel and making a hothouse of the cellar? The extent to which insulation is needed depends upon the system and the immediate conditions. In a hot-water system, it is well to cover at least the boiler and the pipes through which water is distributed to the radiators. Covering the return pipes is also advisable so that the water returns with minimum heat loss. In vacuum and vapor heating systems, it is better to leave the return pipes bare, to

SOURCES OF FUEL LOSSES IN SMALL HEATING PLANTS



Faulty chimney



Leaks in smoke pipes



Poor insulation



Improper firing



Soot in flues



Oil in boiler water



Unburned gases going up chimney



Faulty radiator valves



Bronze paint on radiators



Inefficient radiator covers



Poor circulation in hot-water system



Poor circulation in hot-air system



Leaks about furnace



Ashes too high



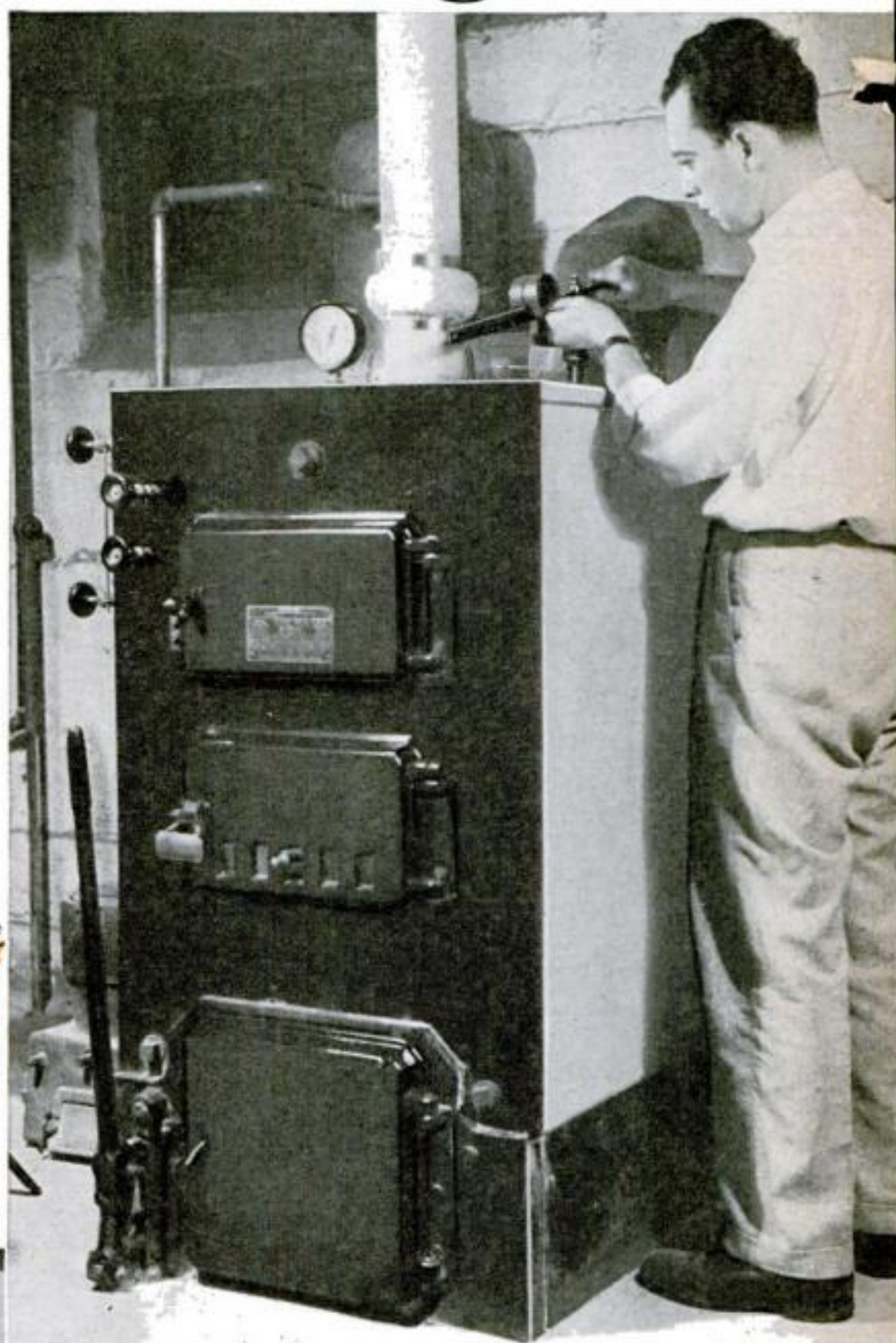
Radiators left on in cold rooms

Home Heating

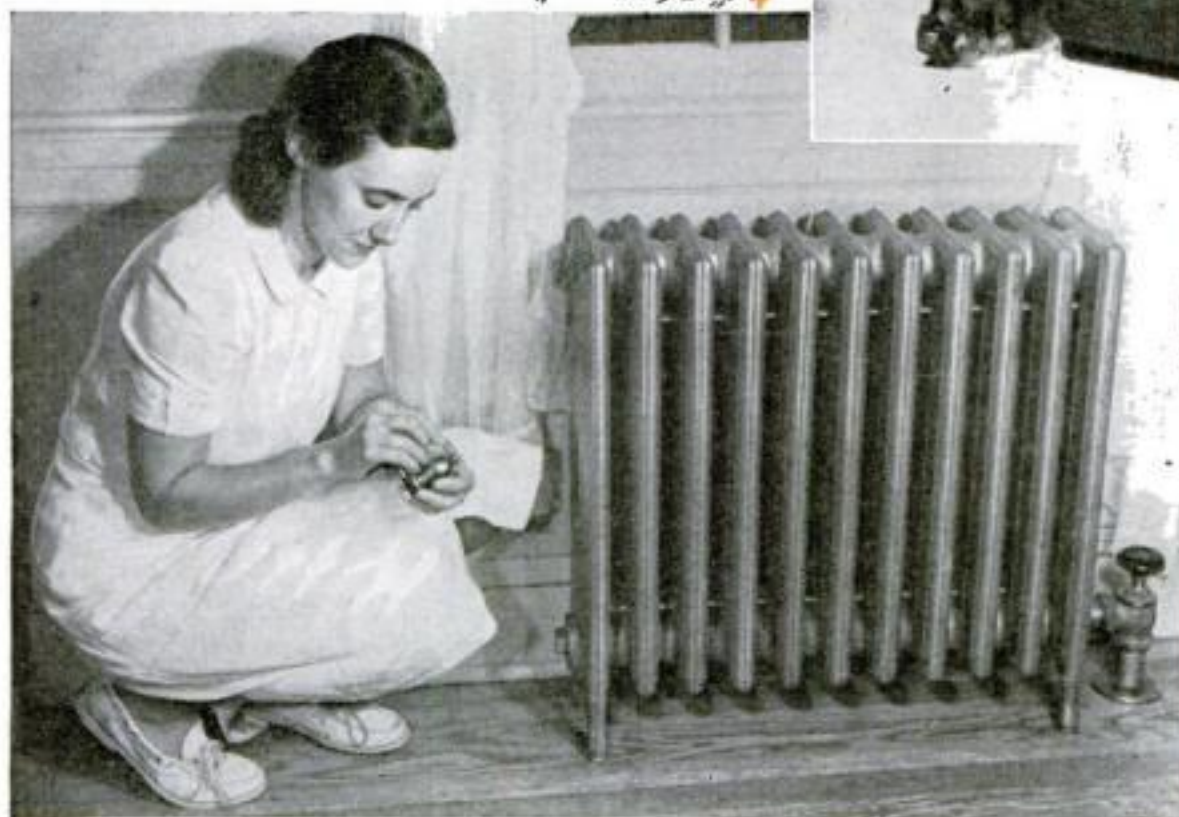
aid in condensing any remaining steam that has escaped into them.

If the boiler is not already insulated, it should be covered with two coats of asbestos cement, the first coat being applied 1" thick and the second $\frac{1}{2}$ " thick. If pieces of insulation have broken away, the bare spots should be filled with this cement. Pipes may be coated with cement in two $\frac{1}{2}$ " coats, or special air-cell asbestos coverings may be wrapped around them.

Leaky pipe joints and defective pipes, in all systems, are another cause of heat loss. Inspect the piping of your hot-air system, and the smoke pipe to the chimney. Also examine the boiler for air leaks. Note if the base of the boiler has been properly cemented, and if the



Joints in the hot-air heating pipes can be made tight and secure by pasting on asbestos paper



Inspecting a radiator valve. Right, cleaning the surfaces of flues and fire box. Above at right, adjusting the damper





Below, if insulation breaks away from the boiler, patch up the hole with asbestos cement. Otherwise, some heat will be dissipated into the cellar



Above, insulate cellar piping with air-cell jacketing material. Right, drawing off boiler water to test for oil



space between sections and base has been well sealed with boiler putty.

Is there oil in the boiler water of your hot-water or steam plant? Oil costs money because of the added fuel required for the heat to break down the greater surface tension produced. You can find out by drawing off a little of the boiler water in a small bottle, from a cock under the gauge glass, and shaking it up. If bubbles in the water rise quickly to the top and disappear, there is no oil in the water. If, however, the bubbles remain suspended, there is oil, which must be removed. This may be accomplished either by having a plumber "blow the boiler," or by adding a prepared compound to the water, which combines with the oil and allows it to be drained out.

For maximum efficiency, boiler water should be changed with discretion. Due to the fact that air is constantly being driven out in hot-water boilers and, in addition, is being distilled in the case of steam boilers, stale water is generally better than fresh water. It is less corrosive and holds its heat better. Water, therefore, should be left in the boiler until the amount of sediment makes a change seem advisable.

The idea of banking the fire at night, even with coal fires, has been routed as uneconomical. It is cheaper, experts have found, to reduce the home temperature only a matter of 10 deg. or so at night, than to let the

temperature drop very low and then have to supercharge the fire in the morning to bring the heat up to normal again. In heating plants controlled by clock thermostats, maintain a 70-deg. temperature between, say, 7 in the morning and 11 at night, and a night temperature of about 60 deg.

Radiators left turned on in rooms that are wide open to the cold are another source of fuel waste, as they lower the heat in the entire system, and force the furnace to increased output.

In the economical adjustment of the fire in gas and oil burners, so much delicate and intricate mechanism is involved that the average home owner must rely for this upon the technical expert. Unless something seems seriously wrong, burners need be cleaned, checked, and adjusted only about once a year.

In the hand-fired coal furnace, however, careful checking and attention may pile up savings that run up to forty percent of a careless home owner's bill. Begin your checking with the chimney, as consistently poor combustion is due to an improper draft.

Often a chimney is too large or too small, or its efficiency is cut by a chimney cap, or by a neighboring gable or high building that blocks it. Perhaps its draft is weakened by leaks in the brickwork or by protruding tile. The inside may be inspected

by holding a small mirror in the smoke-pipe opening. If the draft is found to be too strong, it may be cut down by partly closing the smoke-pipe damper. At the same time, you may economize by using smaller coal. If the draft is too weak, and the fault cannot be corrected, then for good combustion you must keep the coal bed thinner by firing more often, and you must use larger coal to permit air to get through it.

For greatest comfort and economy the coal fire should burn as uniformly as possible. As a rule the fire box should be kept full, and it is better to put on coal enough to last for half a day than to feed it in dribbles. Shake the grates no more than necessary to permit a flow of air through the fire. When the weather is mild, the fire should slumber on a bed of ashes from 2" to 6" deep. As it gets colder, shake down the ashes for greater draft, and to give more space for coal above. Clean out ashes every day, as ashes banked up under the grate shut off air and may cause the grate bars to warp.

Control of the rate of burning of your furnace fire should always be by means of the

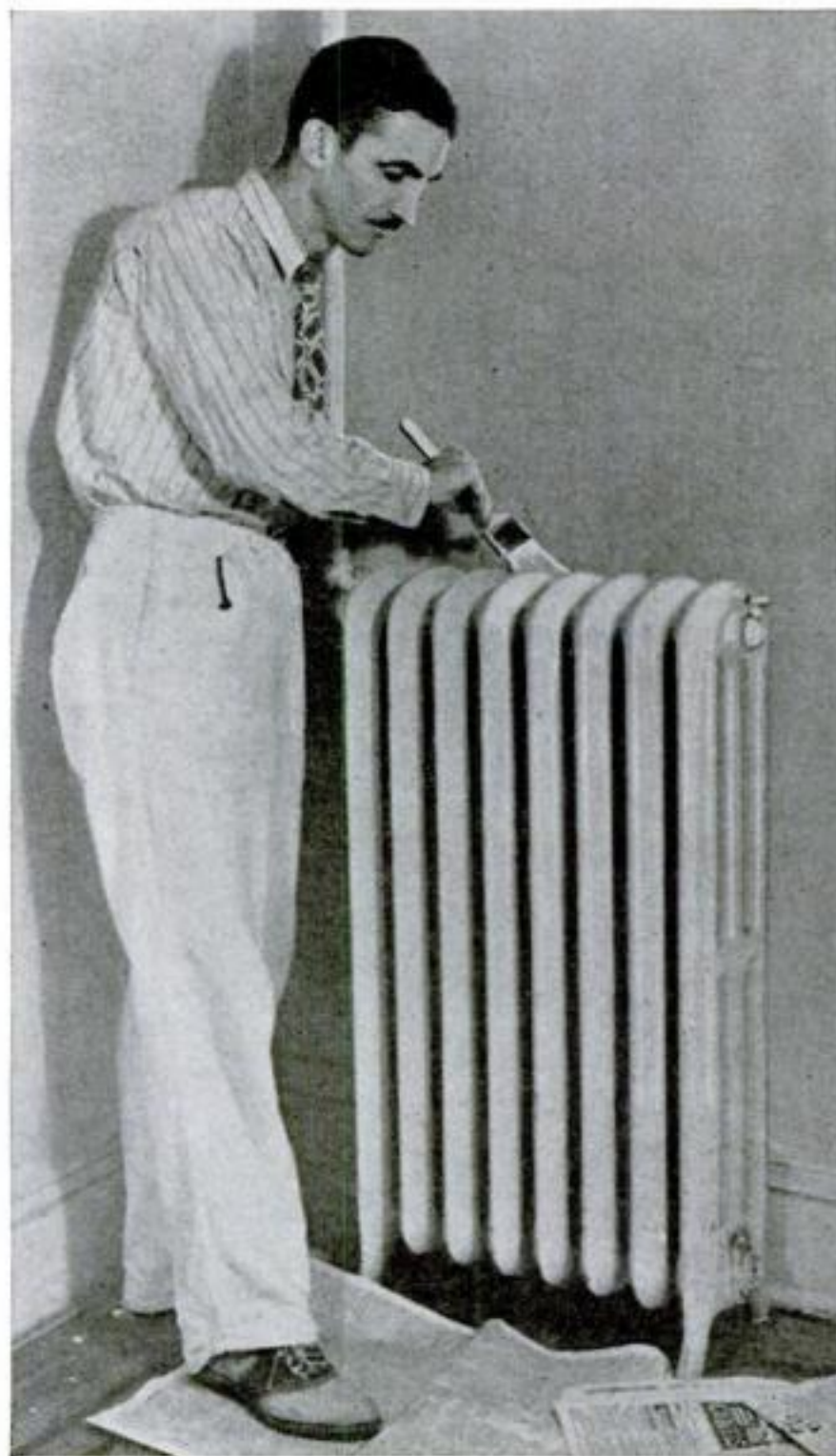
draft damper at the bottom of the furnace, and the check damper in the smoke pipe.

In steam plants these dampers are controlled automatically by means of a regulator, which operates in response to the steam pressure and is adjusted by a sliding weight. Experience best teaches where to keep the weights for various weather conditions. Under no circumstances should the fire door be left open as a check on the draft.

When firing at night in very cold weather, shake down the grate until it is covered with red-hot coals, push some of the coals up in a pile in the back, then fill the fire pot with coal, leaving a "red spot" in the back glowing through. This full pot and the deep fire will burn the least coal, allowing plenty for the night and some for the early morning.

The "red spot" is the secret of additional saving. It burns the surface gases that would otherwise go up the chimney.

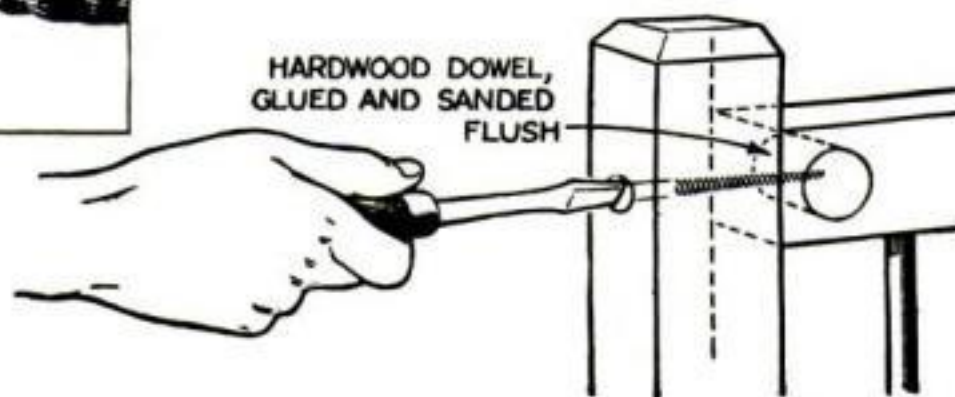
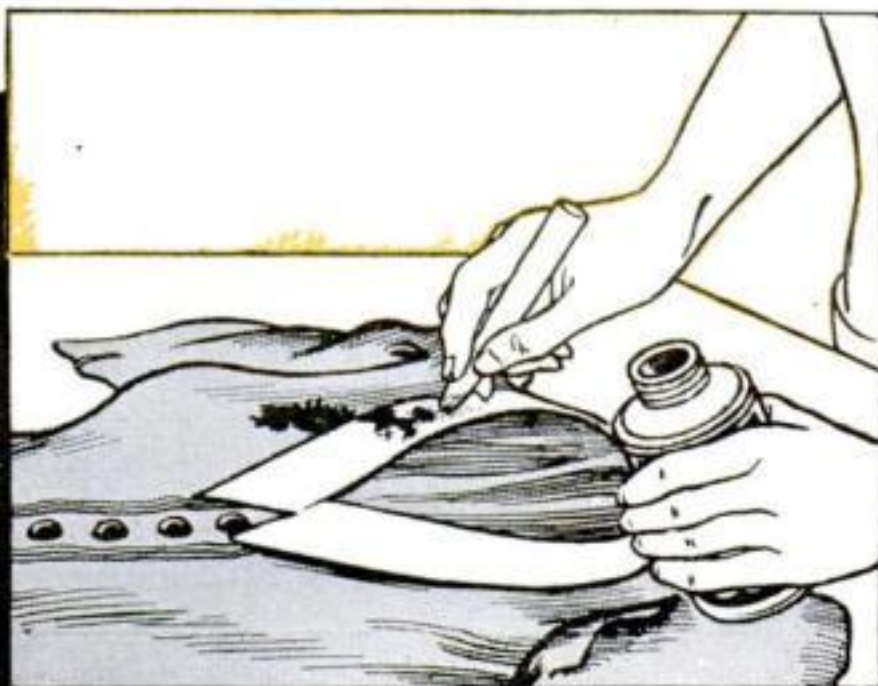
Clean furnace flues constitute a final drastic source of fuel economy. Dust and soot on these flues insulate them from the fire as effectively as an asbestos coating. Cleaning the flues with a wire brush or scraper every month is none too much.



Left, repairing cracks in smoke pipe and chimney fixtures. At far left, give the radiators a good coat of linseed-oil paint to match the woodwork in the room. Below, an automatic electric circulating pump for a hot-water system saves fuel by insuring more uniform distribution of heat

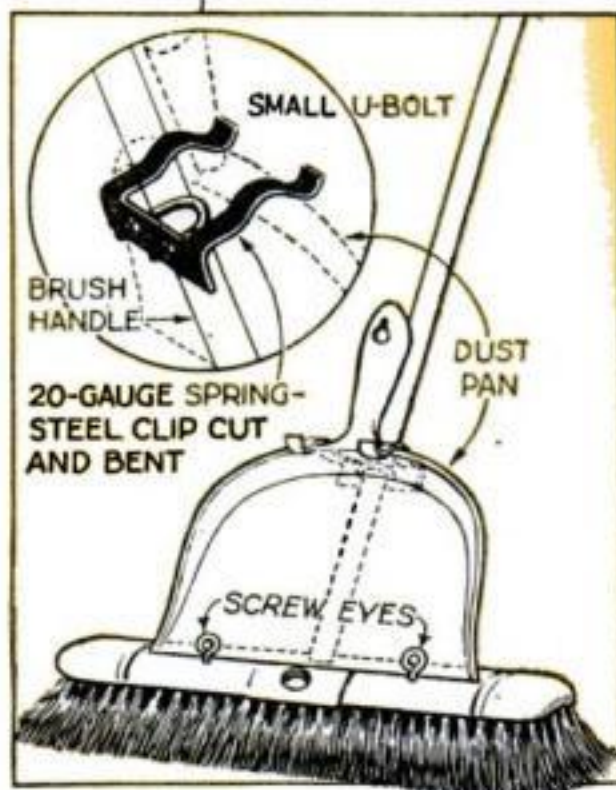


Keeping the Home



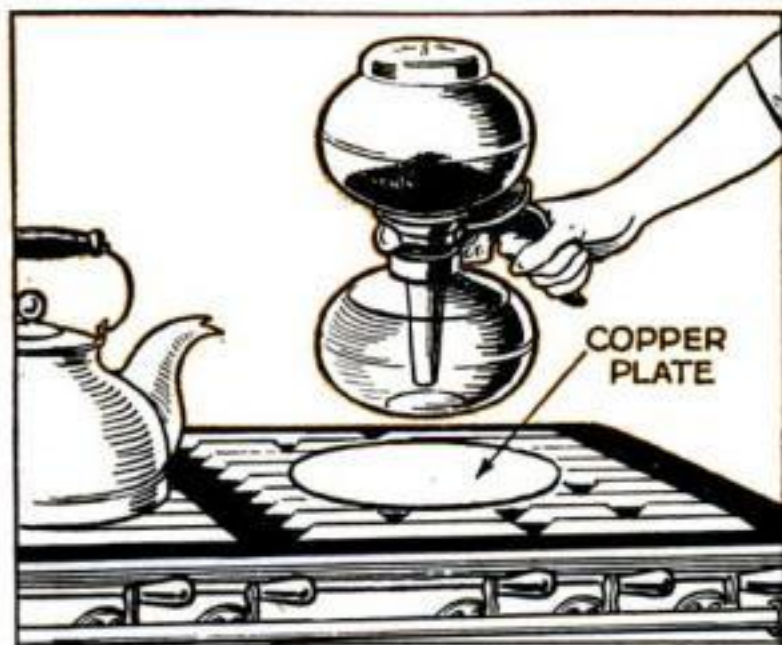
SHORT-STEMMED ROSES can be arranged in a vase with long-stemmed flowers by using straws. Insert the stems in the straws; then trim to the desired length

THE DUSTPAN IS ALWAYS handy if it is attached to the floor brush as at the right. Two screw eyes and a spring-steel clip hold it tightly against the handle



CLOTHESPINS HEATED IN the oven for a few minutes will help keep your hands from getting numb when hanging up wet wash outside during the winter

Shipshape



A 1/32" COPPER PLATE 9" in diameter placed between gas flame and an all-glass coffee brewer prevents the latter from cracking if the flame is too high



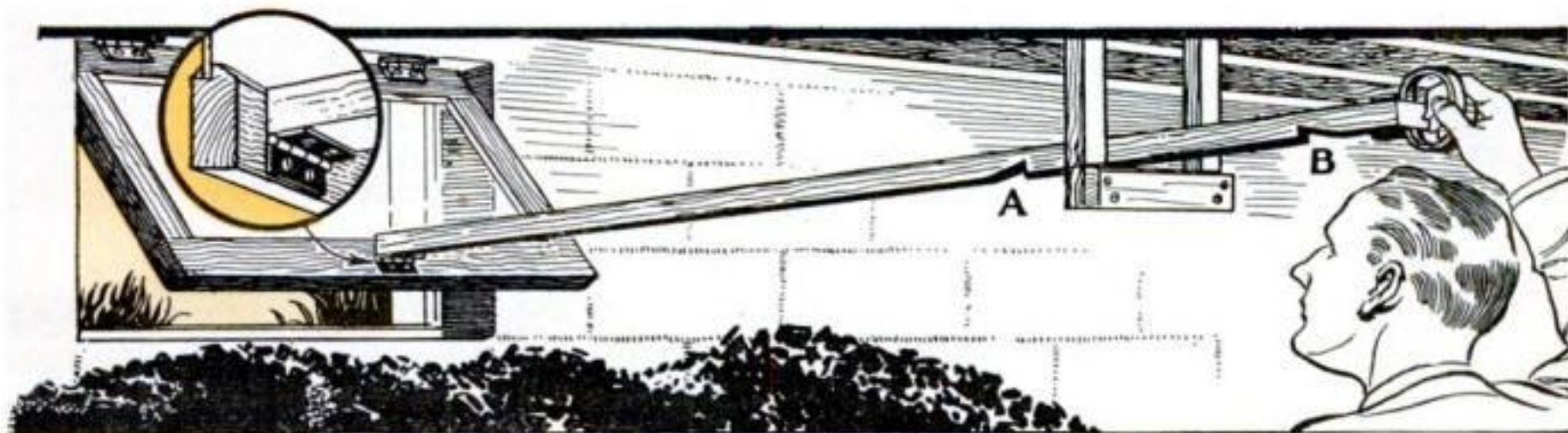
THIS ATTRACTIVE HANGING BASKET is made from an old auto headlamp and some chain or light rope. Remove the lens, reflector, and wiring from the lamp and replace the rim. Drill three holes around the rim, equally spaced, for fastening the chain or cord



IF THE HOT-WATER BAG LEAKS, you can still use the bag by filling it with hot salt. Heat the salt in a pan and pour it into the bag with the aid of a small funnel



TO PREVENT THE END of a curtain rod from catching in the material when pushed through the hem, cover the end with a strip of cellulose tape



REMOTE CONTROL FOR WINDOW. You don't have to crawl over the coal to close the coal-bin window with this arrangement. Cut two notches in

the long extension arm so that notch "A" holds the window open and notch "B" keeps it tightly shut. Fasten the two uprights to the floor joists above

Cleaning

VENETIAN blinds should be taken apart in order to clean them properly. Daily dusting and wiping may remove surface dirt, but after blinds have hung awhile, nothing will make them look like new but a thorough renovation.

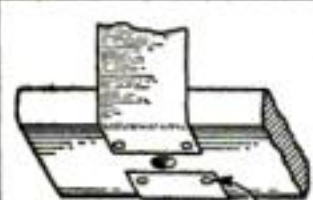
To take a Venetian blind apart, first tip up the bottom rail. If the lift cord (the cord that runs up through the blind) is just doubled back upon itself and jammed into a small hole, pull the cord out with small pliers. If the lift cord is concealed under the ladder tape (the woven tape which supports the slats), which has been tacked across the bottom rail, slightly raise one edge of the tape and pull out the lift cord and untie the knot at the end. Do this to both cords, then pull the cords up through the slats. With the cords removed, the slats can easily be taken out.

Dust the slats with a dry cloth. Then lay each slat on a flat surface longer than the slat (to avoid breakage) and wipe with a cloth dipped in soapy water. Go over the entire surface, first on one side, then the other. Wipe both sides with a clean cloth wrung out in cold water. Finally, rub with a dry cloth. The work can be done faster if the slats are cleaned on old newspapers, which can easily be discarded as they get dirty.

In cleaning the slats, a fly spot or other blemish may be encountered that cannot be removed merely by going over it with a soapy cloth. In that case, place a pinch of granulated soap powder on the spot and rub energetically. It will generally give way.

Furniture polish sometimes proves of value in removing blemishes, and it will also make the slats glossier and easier to dust.

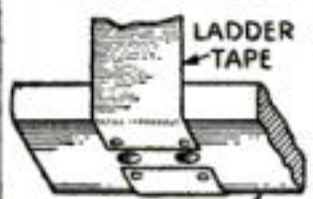
If you have light-colored ladder tapes to clean, an easy way is to use an ordinary quart Mason jar. They must be dry-cleaned because they are cotton and shrink very easily.



TACKS, SCREWS, OR STAPLES

CORD

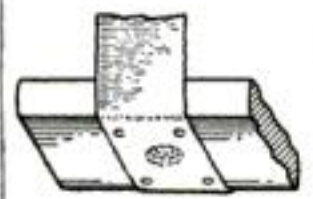
METAL EYELET ON END OF CORD, CORD THEN DOUBLED BACK



LADDER TAPE

BOTTOM RAIL

METAL EYELET ON END OF CORD, EYELET END THEN PUSHED INTO ANOTHER HOLE



TAPE TACKED ACROSS RAIL, CORD KNOTTED ON END AND PUSHED BACK INTO HOLE

First step in cleaning Venetian blinds is to take out the lift cord, which may be attached to the bottom rail by one of the methods at the left. Below, the tapes are unfastened and put in a jar of dry-cleaning fluid

By

MEL MENDEL



TILT RAIL

TAPE LADDER

Venetian Blinds

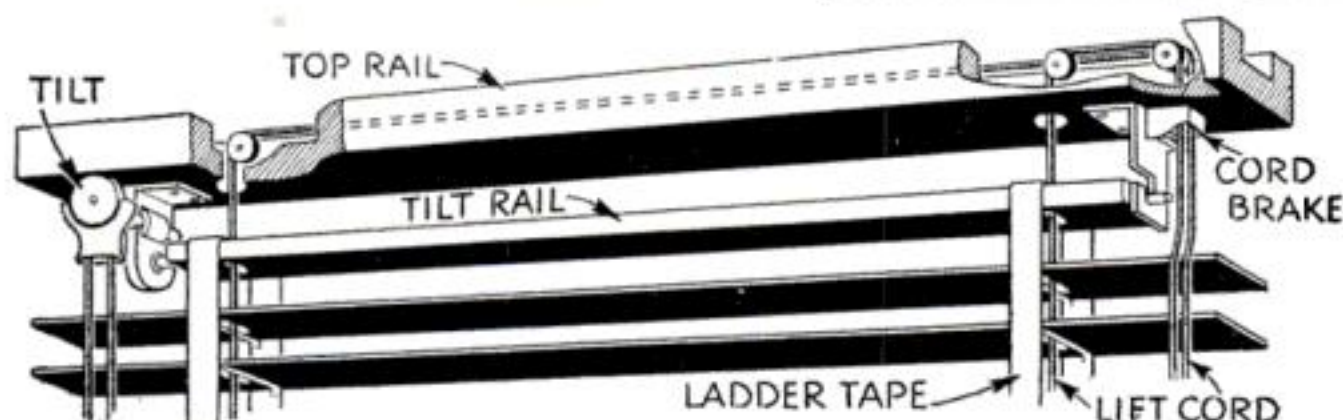
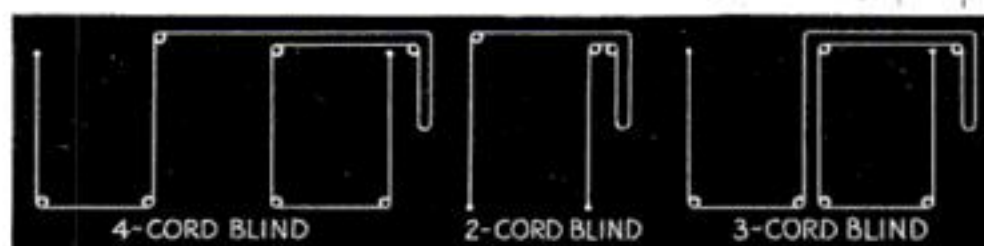
To remove the tapes, first take the slats out of the blind as outlined before. Then remove the small gimp tacks, staples, or screws that hold the tape to the bottom rail and the tilt rail. After the tapes are free, carefully measure their length with the tapes stretched tight. Roll the tapes up and place them in the glass jar. About two tapes can be accommodated at a time. Fill the jar with dry-cleaning fluid, screw on a cover, shake the jar well, and let it stand for a few minutes. Shake again and remove the tapes. Measure the tapes for length and dry them while stretched to that length.

If you wish to change the color scheme, the tapes and cords can be dyed by a local cleaning and dyeing firm or with household dyes at home. If new cords and tapes are purchased for dyeing, be sure to add enough to allow for shrinkage. When the old tapes are used, measure them first, then stretch them as much as possible before dry-cleaning them. As soon as the tape and cord have been dyed and rinsed properly, stretch the tape to the proper length and dry it while stretched.

In case you have a large number of blinds to be cleaned and they are of a type readily removed from the windows, it will pay to fasten two 4" angle brackets on the basement wall or in the garage to facilitate taking the blinds apart. Place them so that

the longest blind will hang about 4" off the floor.

In restringing the cleaned blinds, it is somewhat confusing to remember the path of the lift cords. This is indicated, however, for both narrow and wide blinds in one of the accompanying diagrams. You will undoubtedly find that all such problems solve themselves once you start work.



Above, each slat is wiped with a cloth dipped in soapy water; also three arrangements of lift cords and pulleys. Left, blind assembly

Metallic Insulating Paper Used for Making Light Reflectors

EXCELLENT light reflectors for various purposes may be made inexpensively from the type of insulating building paper that consists of paper faced on both sides with aluminum foil. One large store has been using it at a considerable saving in the

power bill because it reflects more light than ordinary reflectors. It is also possible to use this material or plain aluminum foil for making shades over workbenches. It has even been used successfully in salvaging old auto reflectors.—KENNETH GRAY.



Pocket Tobacco Can Holds Painter's Line and Chalk

AS A REEL for his chalk line, one sign painter finds an empty tobacco can serves the purpose better than a piece of board. A slot cut into the top of the can holds the knotted end of the line. The can also acts as a container for the usual half spheres of chalk. Masons, who also use chalk lines, will find this hint equally helpful.



How to Score Building Paper So It Can Be Torn Straight

A TOOTHED tracing wheel of the type used by dressmakers, boat builders, and others is a good tool to score light roofing or building paper so that it may be torn.

• • •

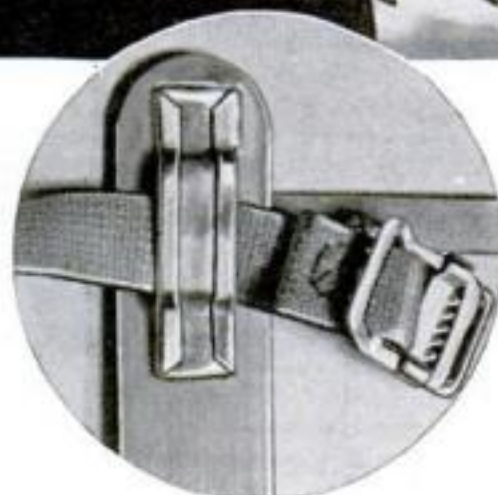
HIGH-GRADE furnace cement in putty form can be used to repair cracked fire bricks if the bricks are otherwise intact.—L. J.

Strap Keeps a Music Stand in One Compact Bundle

A FOLDING music stand is unhandy to carry without a case, yet a case adds to the bulk and is just one more item to keep track of. One musician solved this problem by soldering a piece of sheet metal as shown to the back of the upper end of the middle part of the desk. This loop holds a short web strap in place. When the stand is folded, the strap is buckled around the parts and keeps them together with practically no increase in bulk.—JOHN M. AVERY.



The two parts of a music stand can be kept together, when a case is not used, by means of a short strap. This is held by a metal loop as shown in the circle



Envelope-Sealing Moisteners Made from Small Bottles

Two quickly made sealers for moistening ordinary envelopes are illustrated. One is made from a small bottle with a composition screw cap, the other from a mucilage bottle for which a special stopper is whittled from a scrap of wood. The width and depth of the V-slot in the wooden stopper are best found by experiment. The bottles may be painted, but not the bottom because it is used to smooth down the envelope flaps.—W. E. H.





Clamps for Uneven Surfaces

SPRING wooden clothespins, which are often used as small clamps, can be considerably improved for certain types of work by discarding all but the springs and cutting new jaws from $\frac{1}{2}$ " hardwood to the shape shown above. These jaws are much better for gripping uneven surfaces because there is no twist or side thrust to throw the freshly glued work out of line as when ordinary clothespins are used.—L. A. L.

Soft Rubber Thumb-Tack Cup



THUMB tacks are easily picked out of a cup made from half a rubber ball as shown. It is attached to the drawing board in any convenient place by means of a single long-pointed thumb tack.—E. H.

Shellac and Wax Preserve Much-Used Bookbindings

TO KEEP bookbindings in good condition, a public library uses a simple method that is equally suitable in the home, particularly for books kept in the workshop or otherwise subjected to hard wear. Merely brush on a coat of white shellac, allow it to dry thoroughly, and then apply paste furniture or auto wax. Rub the wax to a high polish. This finish resists constant handling and moisture and is easily cleaned.—E. B.



Furniture or auto wax is applied over a coat of white shellac to protect the book covers from wear

Cleaning Separator Bearings

WHEN a cream separator turns hard and stops with a droning chug at a time when you are too busy to give it immediate thorough attention, try this little trick: Drain the gear case and flush with kerosene. Then refill with one part penetrating oil and two parts of the usual oil. This will often free the bearings of residue and restore the machine's efficiency.—ROYCE M. ROATH.

Folding Card Table with Only Two Legs Open Provides a Coasting Incline for Toys

IF ONLY two of its legs are opened, a card table will provide a suitable incline upon which children may operate small toy autos and trucks as speedy coasters.

• • •

BEFORE being repainted, rough-textured or plastic-paint walls can be improved by cutting down the high points of the old paint with a portable disk sander.



NEW IDEAS FOR YOUR

CHRISTMAS



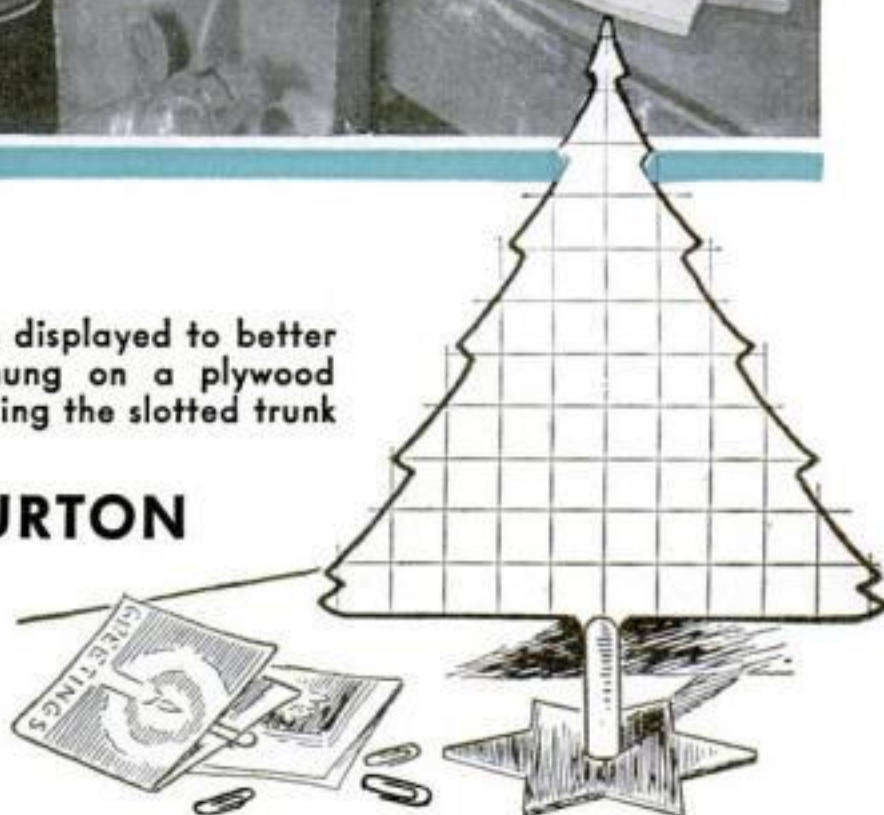
Christmas cards are displayed to better advantage when hung on a plywood tree. Above, attaching the slotted trunk

By **WALTER E. BURTON**

MANY unusual but inexpensive decorations can be prepared during the next few weeks for creating a holiday atmosphere in your home this Christmas.

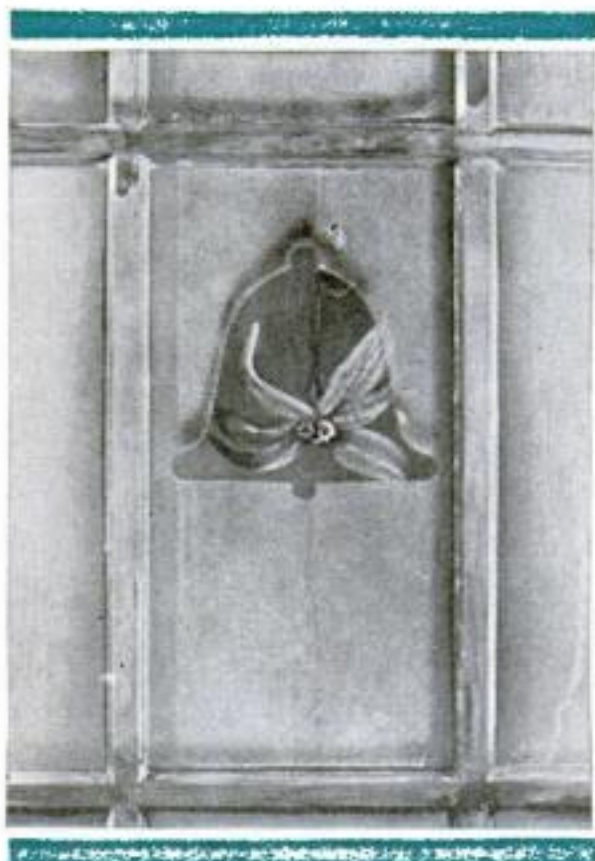
For example, when the Christmas cards begin to come in, do you, like most people, toss them helter-skelter into a box? It's much more fun to hang them on a decorative wooden Christmas tree like that illustrated above. Cut the tree from $\frac{1}{4}$ " plywood, make a trunk from a length of dowel rod, broom handle, or any available round stick, and cut a star-shaped base from $\frac{3}{16}$ " or $\frac{1}{4}$ " plywood. The tree shown is 26" from base to tip and $18\frac{1}{2}$ " wide; the trunk is 1" in diameter and 4" long; and the base is a six-pointed star laid out in a circle 9" in diameter.

Paint the tree bright green or red to harmonize with other gay Christmas decorations. Drive small brass escutcheon pins (or



ordinary pins cut to $\frac{3}{8}$ " long) into the tree so that the heads project $\frac{1}{8}$ ". To hang a card up, slip a small paper clip over the upper edge at the center and let it project a little; then place the loop of the clip over the head of a pin. Circles of brightly colored paper or paint will make the tree more attractive before the cards begin coming in and when it is only partly filled with the greetings.

Christmas bells and wreaths hung behind windows or glass doors are sometimes wholly or partially obscured by the steaming or frosting of the glass. This is especially likely to happen while the Christmas dinner is being cooked. To keep the glass clear, you can use to advantage the transparent



How a frosted window appears with a bell-shaped film and decoration

DECORATIONS

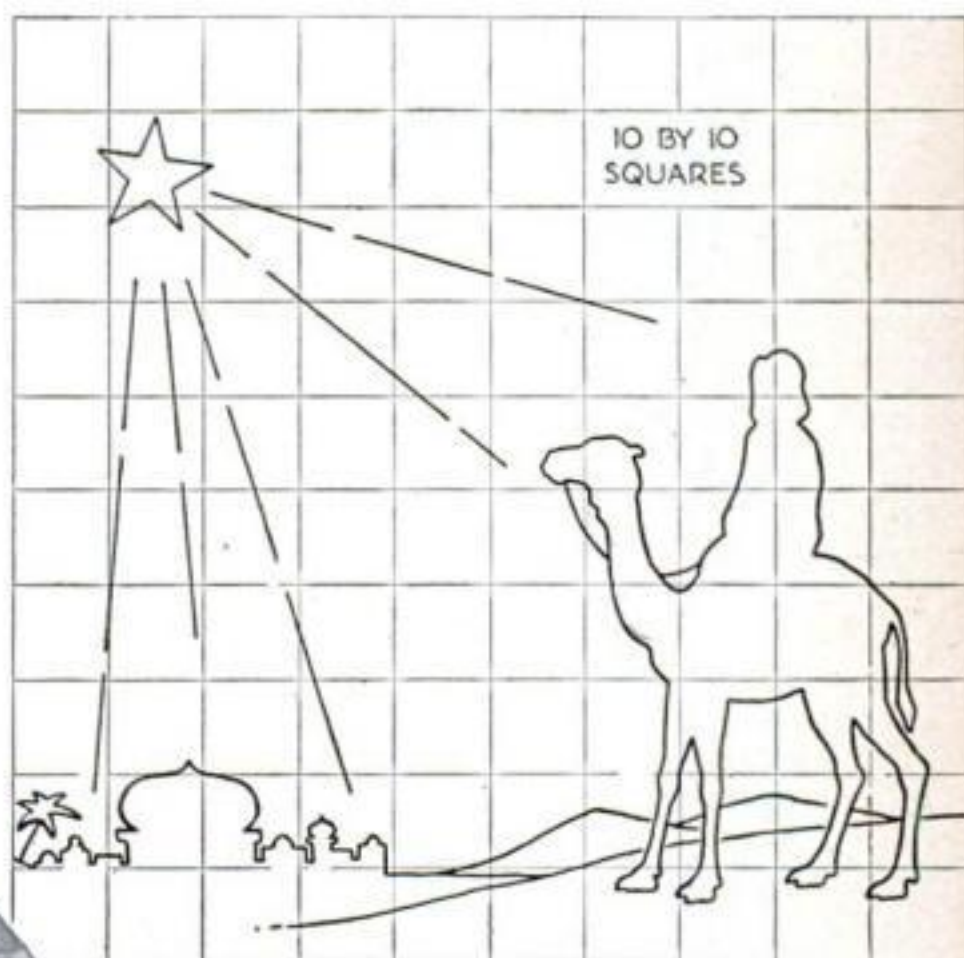
films sold for cementing on automobile windows. These films are commonly sold in the form of kits consisting of several sheets of the transparent material, a can of cement, rubber squeegee, and a piece of viscose sponge to mop up excess adhesive. When the film is applied to glass, frost and water vapor will not condense on it except at very low temperatures.

Novel decorations for windows are made by cutting the same film into such Christmas shapes as bells and stars. To apply the cut-outs, dip them into the adhesive solution supplied with the film and squeegee them to the glass. When the window becomes steamy or frost forms, the designs will appear as transparent areas. The film is easy to remove later on. It merely requires to be moistened.

Another type of decoration, visible by day or night, can be made from an opaque, dark-colored window shade. Sketch an appropriate design on a piece of paper large enough to cover the lower half of the window. Fasten the drawing

to the shade with adhesive tape, and use a large needle to punch holes about $\frac{1}{8}$ " apart, outlining the design*. Then remove the paper. When the shade is hung over a window in the daytime, the design will be seen from

*A variety of Christmas designs to suit almost any project, from a huge roof-top silhouette to a small place card, are given on a page of drawings following this article.



When enlarged, this design is transferred to a dark window shade by making perforations





Fastening thread to a toy balloon to be used in a "balloon barrage" for supporting Christmas decorations like those shown at the left

inside the room as a series of bright points of light. At night, a floor lamp with either a translucent shade or none at all is placed behind the shade so that the design will be visible outdoors.

A holiday "balloon barrage" is an unusual way of supporting paper bells, cut-out designs, and other decorations that can be suspended from a ceiling or archway. Inflate some spherical toy balloons and, at a point on top opposite the stem, attach a length of thread to each. To do this, coat a small area with rubber cement, let it dry for a few minutes, then lay the thread across it. Cut a small strip of electrician's rubber tape or the sheet-rubber material made for patching automobile inner tubes, and apply the tacky side to the cement-covered spot, across the thread. Tie the thread around the strip.

Use the thread to suspend the balloon from the ceiling or in an opening between rooms. Tie one end of a length of Christmas-package cord to the balloon stem, and the other end to the decoration. If the thread is of such color that it blends with the background, it will look as if the balloon alone is supporting the decoration.

Sticking Christmas seals

on woodwork, painted walls, and other surfaces is a simple way of brightening the home for the holidays. The seals can be arranged in interesting patterns. However, if you moisten the gummed adhesive on the seals to attach them, you will have difficulty removing them later, so use rubber cement. The seals then can be peeled off later on without trouble. Do not, however, attempt to cement them to wall paper; they would be difficult to remove and the cement might leave marks.



Christmas seals form colorful spots if applied to woodwork. Use rubber cement so they can be removed later on without leaving any unsightly marks

Did you ever think of making special Christmas book ends for the holiday season? One possible arrangement, using cardboard cut-outs, is shown. Obtain or draw on paper a picture of Santa Claus descending a chimney with his pack. Paste this on a sheet of stiff cardboard and cut out the figure, leaving a few inches of extra stock at the bottom. Tint the edges with water color.

Make the chimney in two sections from the same cardboard. Cover the lower section with red paper ruled with black ink in imitation of brickwork, and the upper section or cap with paper colored dark blue or some other appropriate hue. Glue the cut-out figure to the back of the assembled chimney, and then glue a piece of cardboard to the

bottom so it will extend back under two or three books when the book end is in place. Give the chimney cap a coat of clear brushing lacquer and spread on tinsel or glitter.

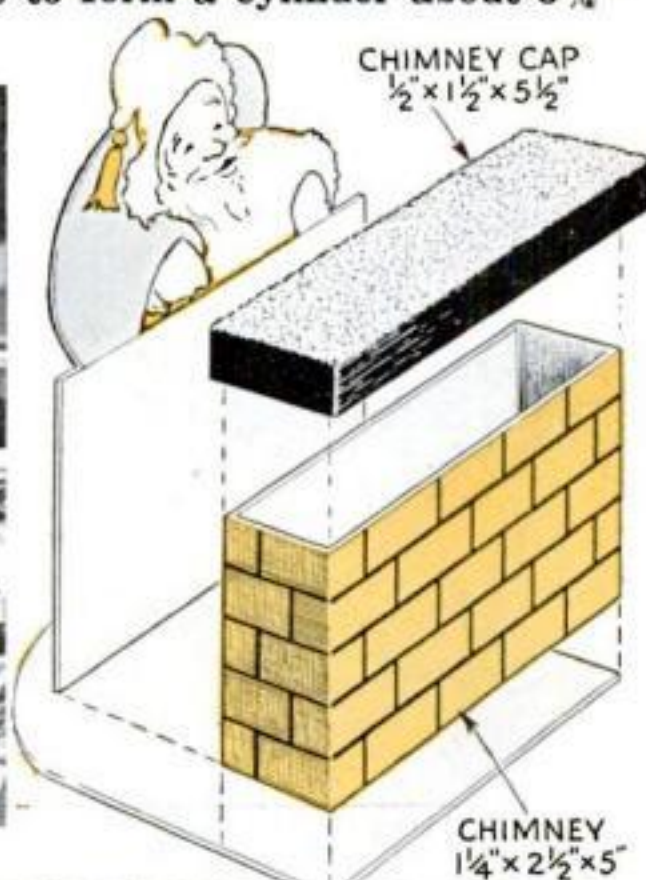
Cardboard shapes for Christmas decorations can be cut without tedious labor by using a sewing machine in which the needle has been replaced by a small chisel-like cutter. It is possible to purchase such cutting bits in some large, well-stocked hardware stores, but it is easy enough to make one by grinding a broken needle to form a thin, flat blade with a beveled cutting end. Set the sewing machine for a short stitch. Such an arrangement will also cut very thin plywood and other soft materials.

By using chemicals, you can add color to Christmas candles and fireplace flames. Sodium compounds give the most brilliant effect—a golden yellow. To color a candle flame, simply place a small amount of baking soda at the base of the wick. This will last for a long time. Washing soda or photographer's sodium carbonate or sulphite can be used as well.

For a fireplace, newspapers can be soaked in a solution of soda, rolled tightly into sticks, and put aside to dry, or pieces of wood can be soaked in the solution and dried. A few such pieces tossed on the fire will produce the color.

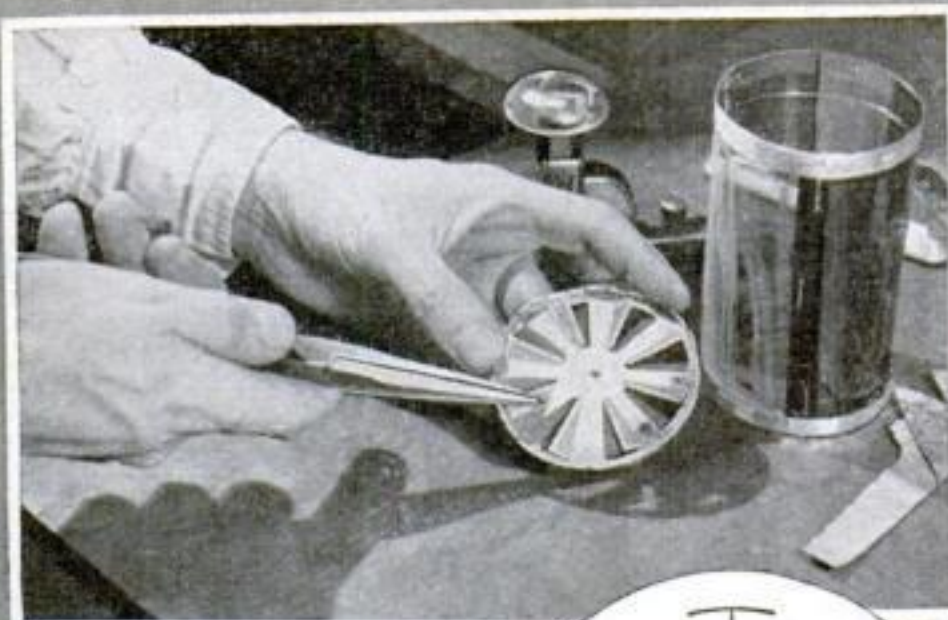
Although sodium flames are most brilliant, other chemicals can be used to produce different colors, as follows: Potassium compounds, violet; copper compounds other than the halides, emerald green; calcium compounds, yellowish-red; strontium compounds, scarlet. The yellow flame of the fire will, however, often mask the weaker colors.

With two easily made color cylinders, you can rig up an attractive window display of ever-changing colored light. Obtain some colored gelatin like that used over theatrical spotlights and store-window lighting units. (Don't use celluloid or inflammable materials.) Cut three rectangular pieces for each cylinder. Fasten blue, red, and yellow pieces (or some other combination) edge to edge to form a cylinder about $3\frac{1}{4}$ "

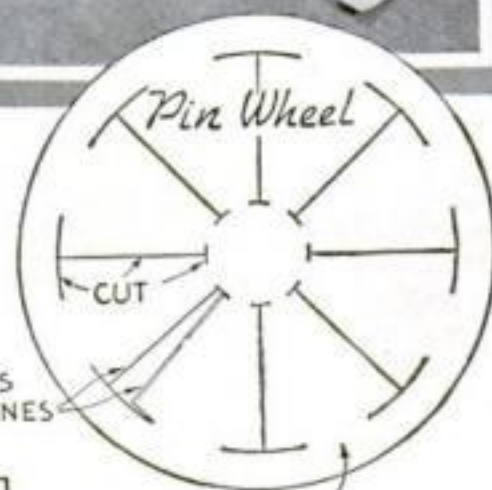


HOW TO MAKE SANTA CLAUS BOOK ENDS

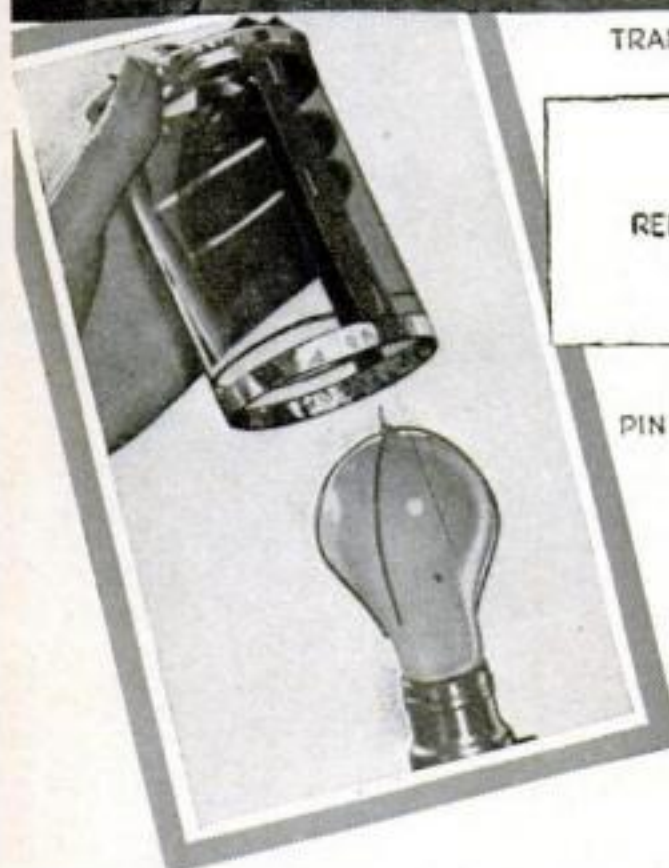
The picture of Santa Claus is drawn on paper and colored, then pasted on cardboard and cut out. The chimney is made of cardboard in two parts and covered with paper. A cardboard base is provided, and the parts, shown separated in the upper right-hand sketch, are glued together



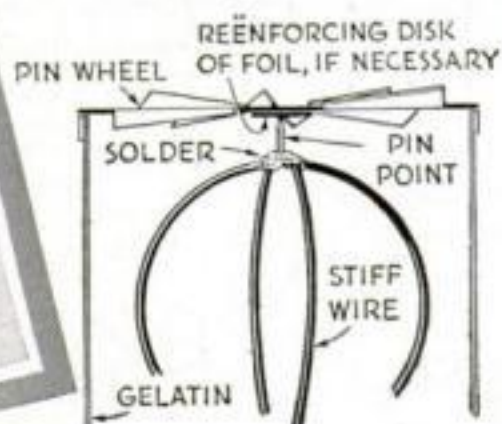
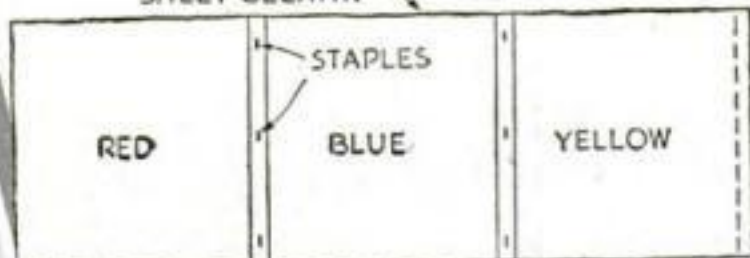
A pin wheel made of heavy foil or very thin metal keeps the color cylinder in motion



THIN SHEET METAL SUCH AS SHIM STOCK



TRANSPARENT, COLORED SHEET GELATIN



ROLL INTO CYLINDER AND FASTEN EDGES

These revolving color screens can be displayed effectively in front of a window. Cover the lower half of the window with thin white paper folded to form vertical accordion pleats. A light wooden frame can be made to hold the paper. Set a lamp on either side, and start the cylinders. A constantly changing color pattern will be seen on the pleats. If desired, you can fasten a star, wreath, or other Christmas design in the center of the paper, to act as a silhouette.

The cylinder is pivoted on a pin point over a 40- or 60-watt lamp. Hot air rises and causes it to revolve

in diameter and 5" long. Use a stapling machine or needle and thread.

Over the upper ends of the cylinders, fasten pin wheels made from metal foil such as that used around photo-film packages, and bind decorative strips of tin foil around the lower ends.

The pin wheels are merely disks with radial cuts as shown. Bend the segments to form blades against which hot-air currents rising about the lamp will strike. Make a wire frame for each lamp, which should be 40 or 60 watts, and at the top solder a short length of a pin, point up. When the cylinders are balanced very carefully on these points, they will rotate as long as the lamps are burning, although it takes a minute or so for them to start.



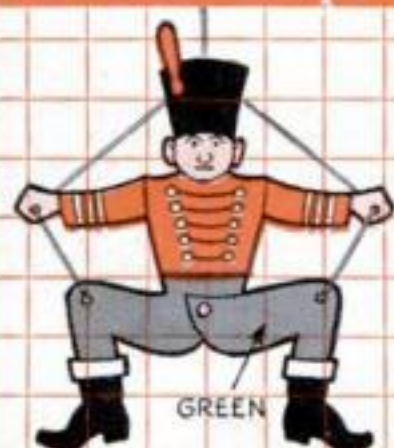
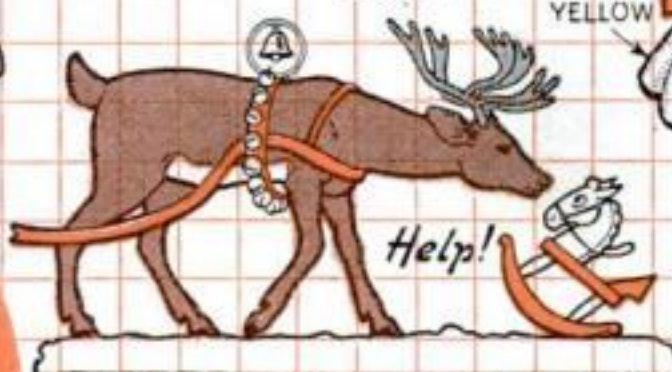
Newspapers, if soaked in washing-soda solution and dried, produce brilliant colors in the fireplace

Merry Christmas

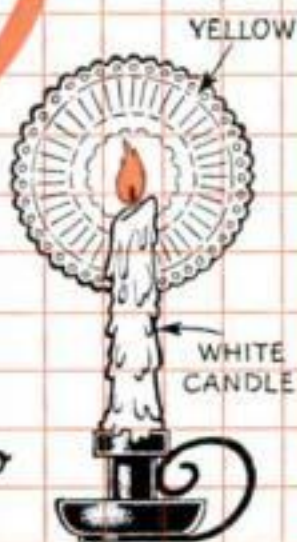
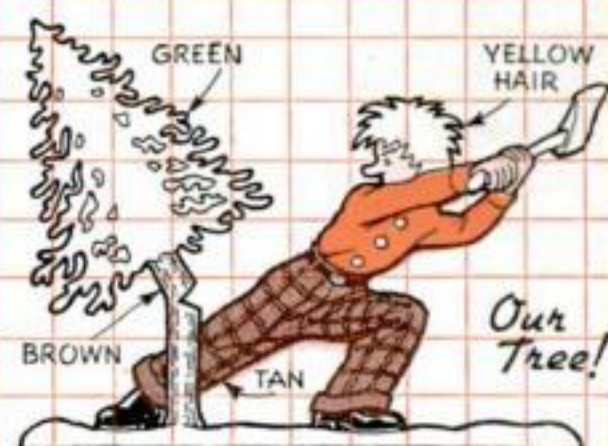
BRIGHTLY colored, well-illuminated figures placed on the lawn or atop the house add to the gayety at Christmas time. Here are some designs for this purpose, as well as ideas for a variety of other decorations, large or small. You can reproduce these any size you wish by drawing proportionately larger squares and copying the outlines from point to point.

He Made It!

BRIGHTLY
COLORED
TOYS



Private Peppy



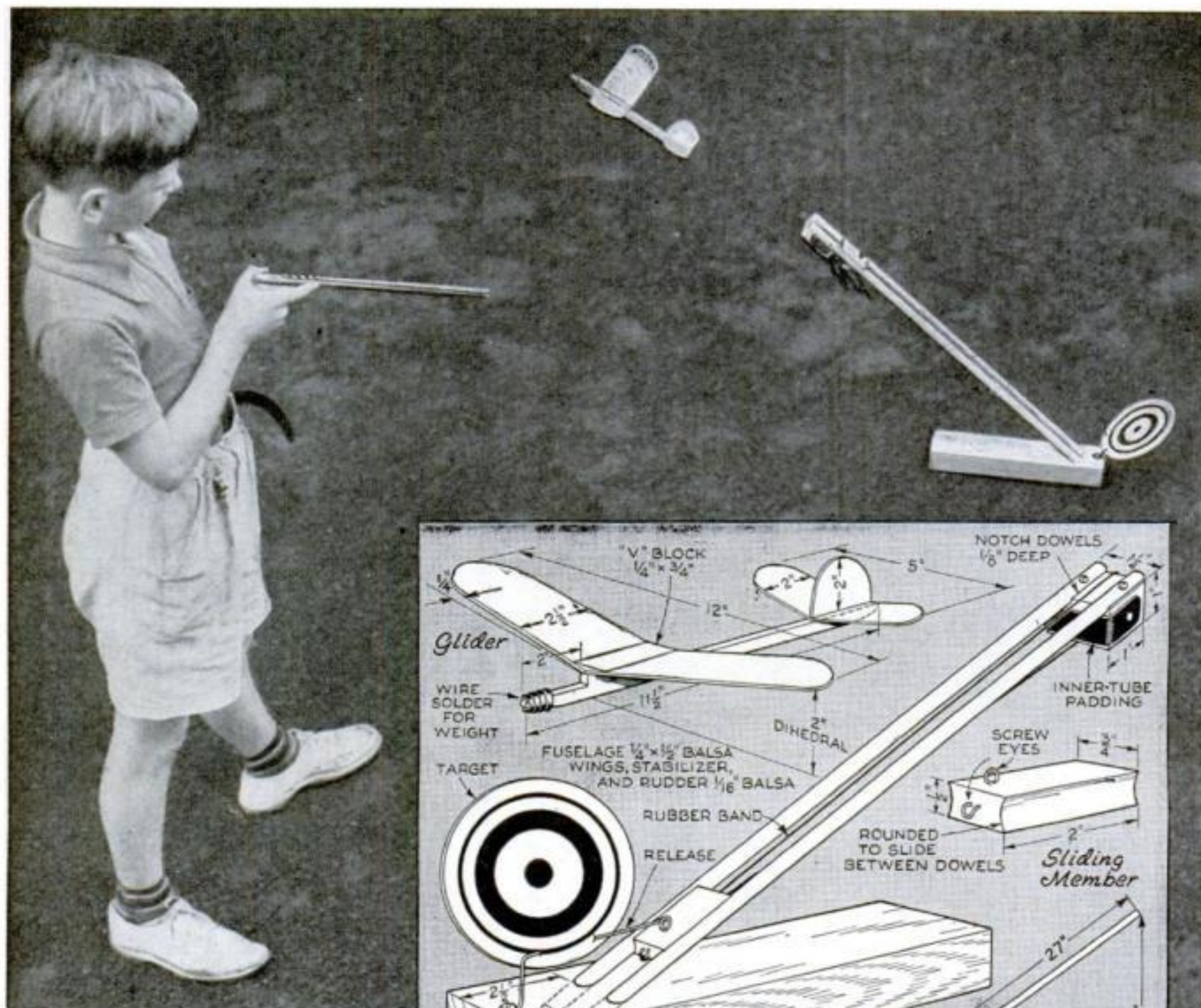
Santa's Helper



Speedy Santa

Toy Antiaircraft Gun

LAUNCHES GLIDER, THEN SHOTS IT DOWN



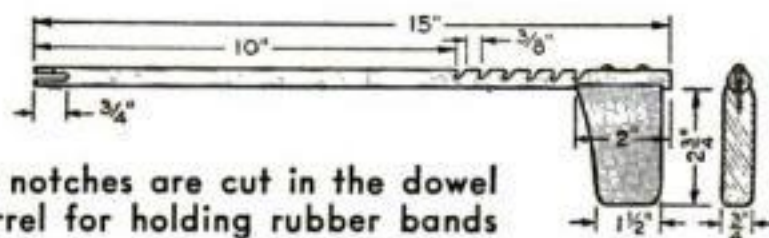
CATAPULTED into the air when the stationary target of this shooting game is hit, a small glider flies up to provide a moving target for the remaining shots on the six-round rubber-band gun. Novel as this game is, it can be easily constructed from scrap materials and will furnish many hours of enjoyment for children.

The catapult is built of two dowel rods set at an angle in a wood base. A cardboard target, wired as shown, releases a sliding member that launches the glider. The small stop block at the top of the catapult is padded with rubber strips.

A dowel attached to a convenient handle forms the gun. A slot at the front and several notches near the handle hold the rubber-band ammunition under tension. The

gun is operated by sliding the rubber bands out of the notches with the index finger. A little practice will soon teach the secret of rapid operation. Aluminum foil is wrapped around one end of the rubber bands to give the bands sufficient firing power.

Any small, simple glider may be used, or one may be built of balsa wood as shown. The front end of the glider must be rounded so that it slides over the end of the catapult.



Six notches are cut in the dowel barrel for holding rubber bands



The doll house is small enough to be stored on a shelf or in a deep drawer. The front swings down to provide an inclosed terrace and a lawn

DESIGNED for apartments or homes where space is at a premium, this tiny doll house can be stowed away under a bottom shelf or even in a deep drawer. Nevertheless, when the wings are opened out and the front dropped forward to form the terrace and lawn, it accommodates a sizable doll family.

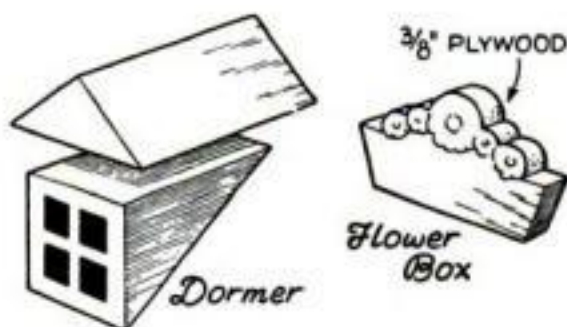
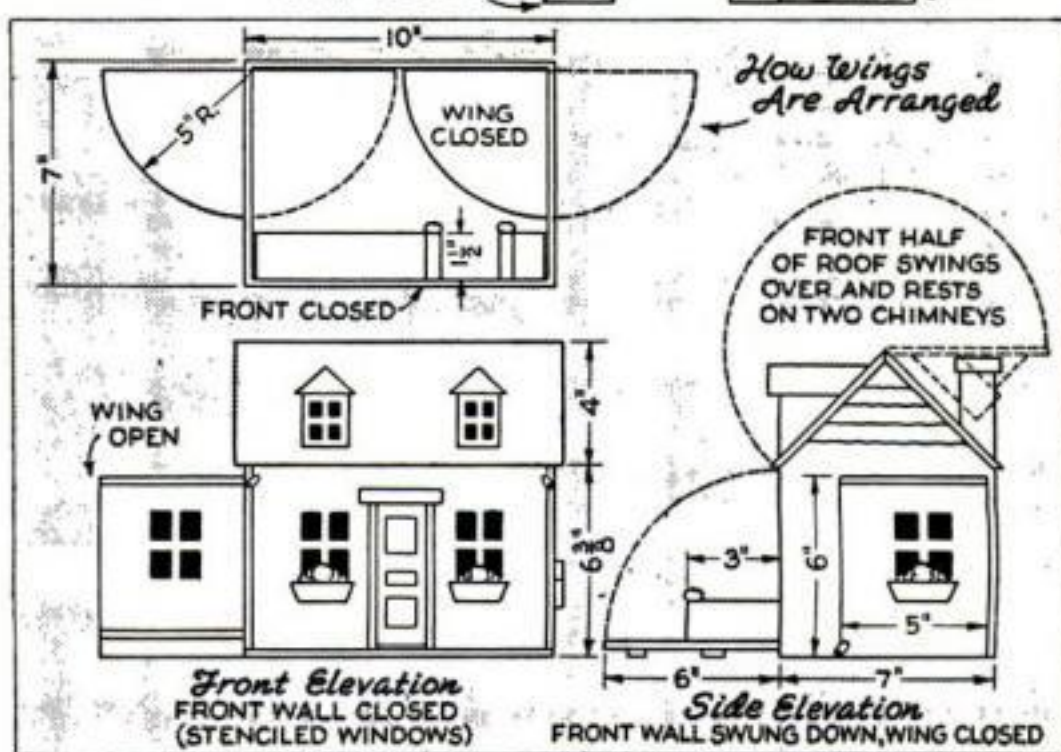
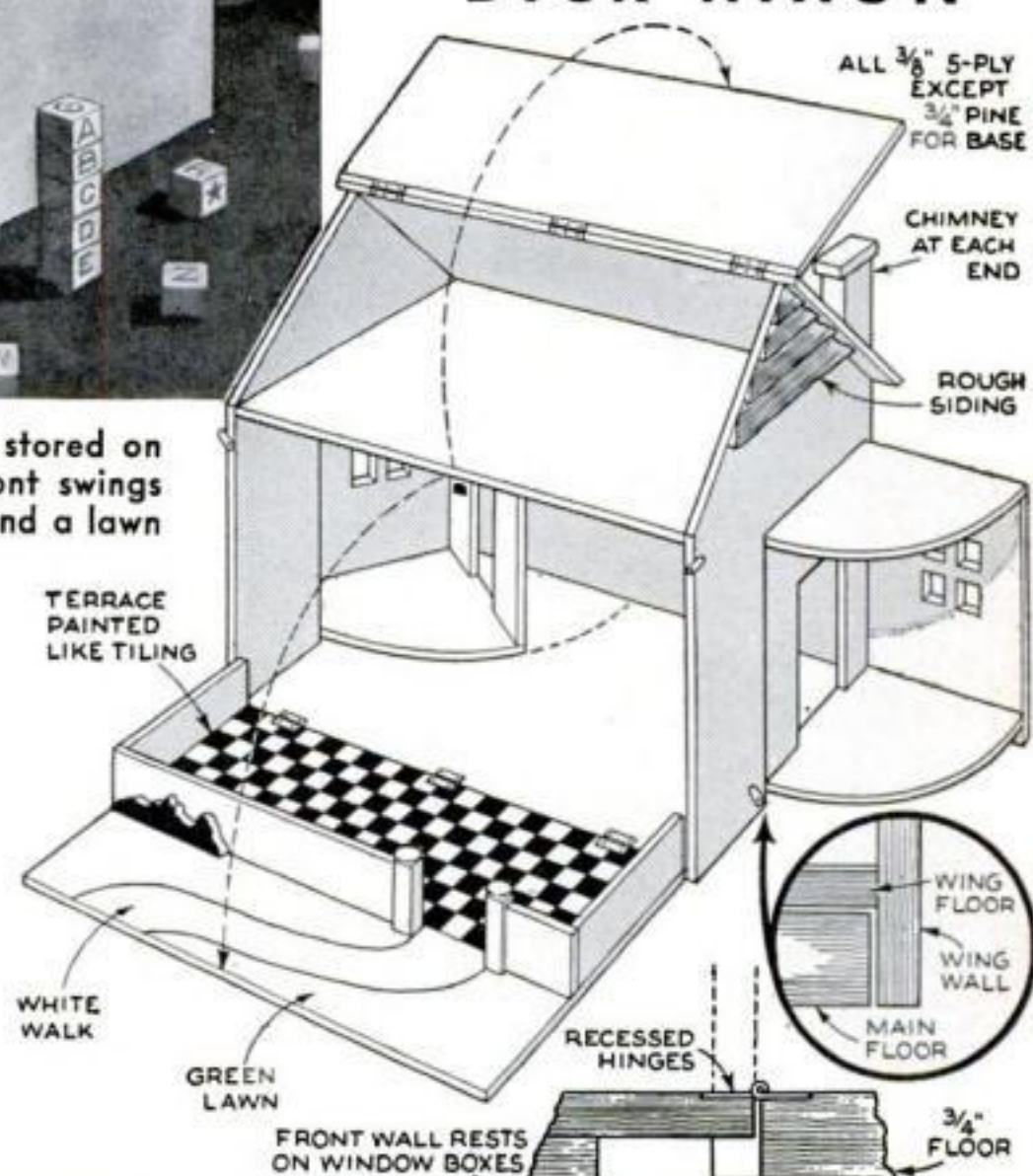
The baseboard is $\frac{3}{4}$ " pine, and the house is constructed of $\frac{3}{8}$ " five-ply plywood, which is sufficiently thick to hold the screws of the small hinges for roof, wings, and front.

Note that the front wall folds flush with the end walls, and is held in the closed position by small catches, which can be made of wood or metal. When lowered, the window boxes support it in the level position. The windows may be stenciled on in blue instead of being sawed out. Dormers are made up of two solid blocks each, as illustrated.

Paint the outside walls cream, the roof red, and the window boxes green with colored flowers. The main floor should be stained and varnished, the terrace painted to resemble alternate gray and terracotta tile, and the lawn painted green. The interior walls should be done in pale shades of your own selection, or they can be covered with plain wall paper.

VEST-POCKET Doll House

By
DICK HIXON



Shape the two dormers and flower boxes from solid wood. The windows may be stenciled in blue instead of being sawed out

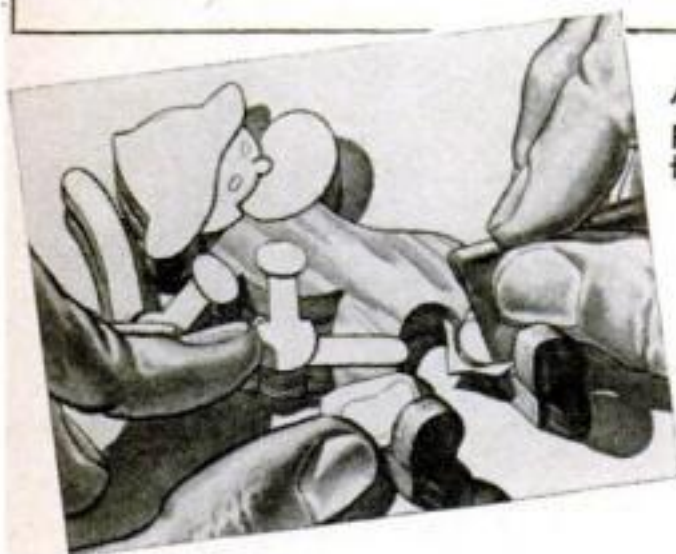
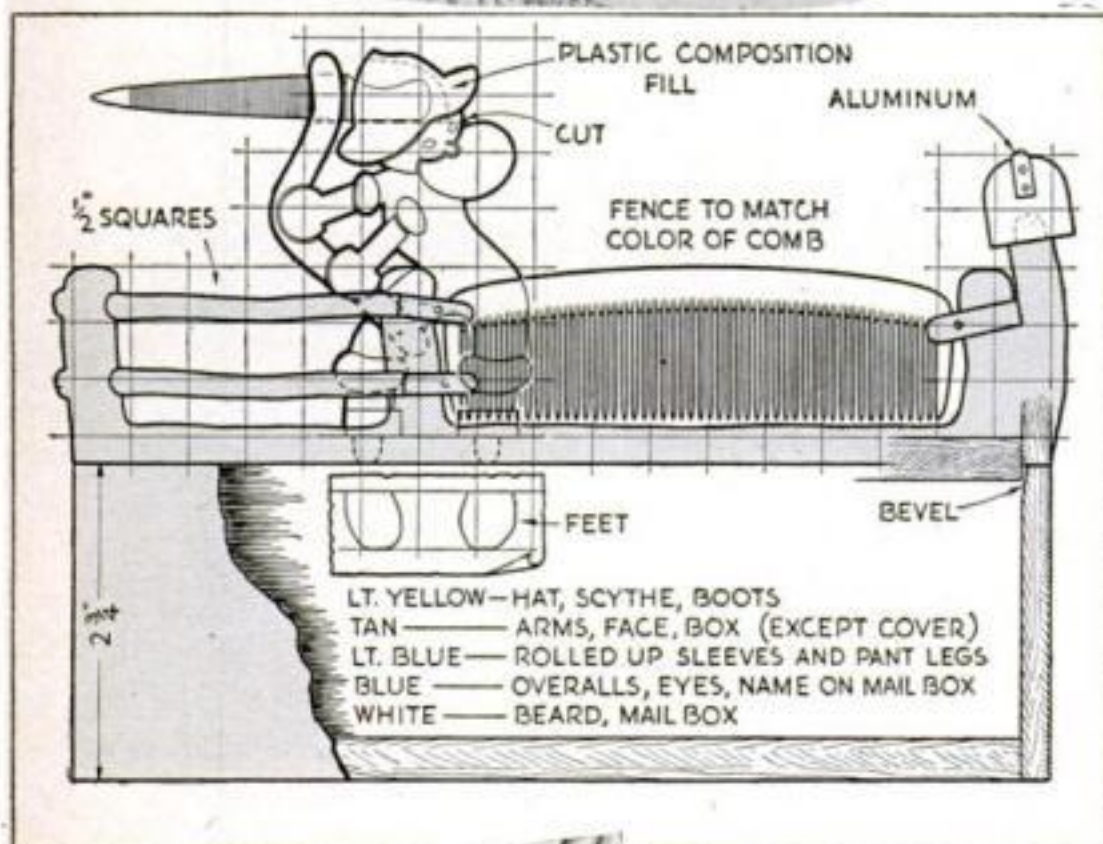
FARMER CUTTING HAY DECORATES Child's Toilet Set



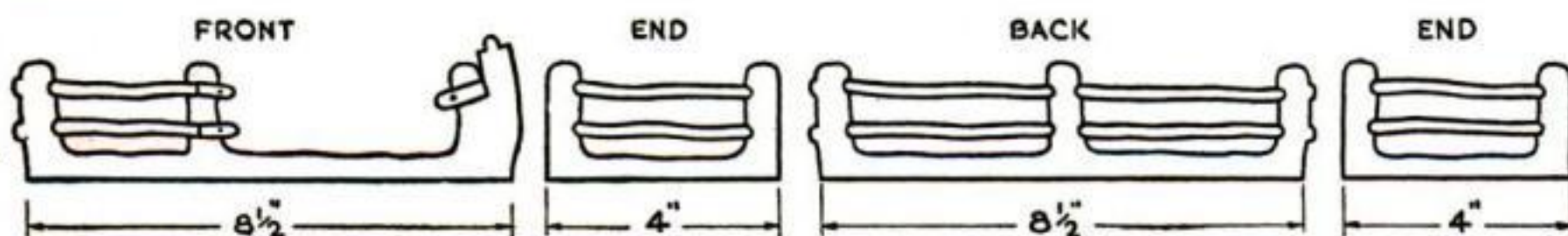
GOOD grooming is easy to "sell" to a small child with this comb, brush, and handkerchief box. The hair brush (representing the hay) and an ivory-colored comb should be on hand before starting, as their sizes may require the dimensions to be altered. The fence is cut from $\frac{1}{4}$ " plywood. Before gluing the fence rails, attach the aluminum "hinges." The fence is nailed and glued to the $\frac{3}{8}$ " plywood box cover, leaving $\frac{1}{8}$ " of the thickness of the cover to fit inside of box. Bevel the inside edges of the cover to insure an easy fit.

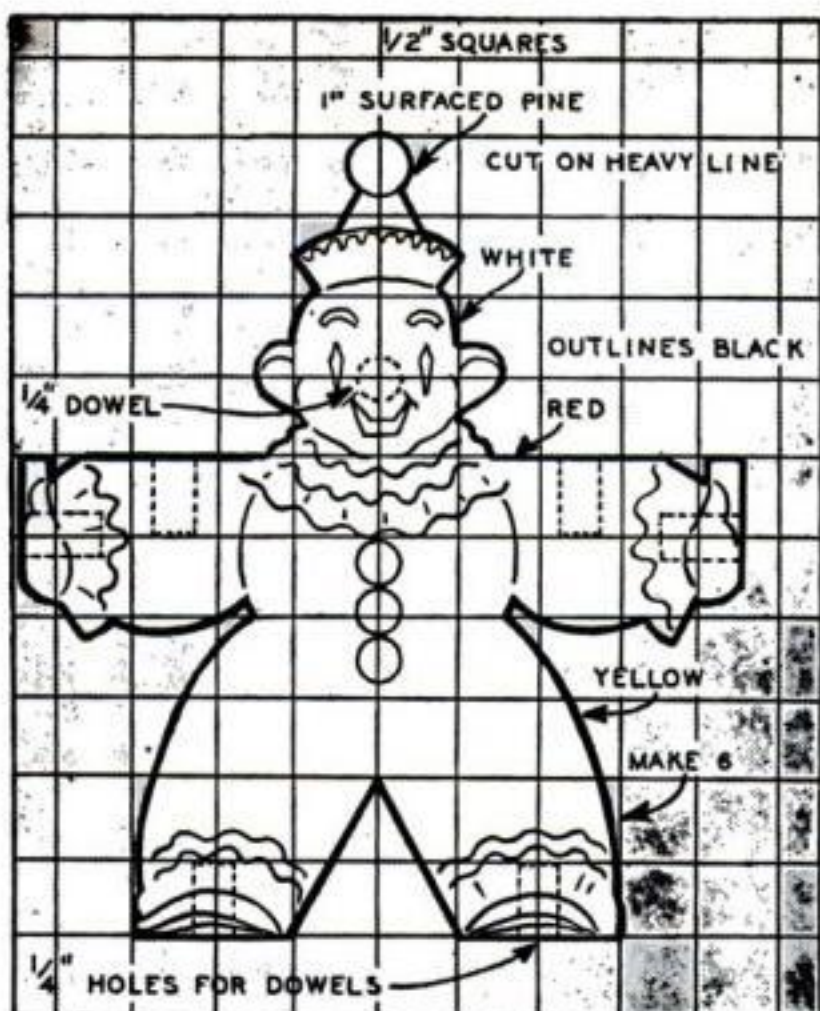
The farmer is jig-sawed from $\frac{1}{4}$ " plywood. Glue overlays of heavy drawing paper on the figure as shown in a small illustration. Trim them and make V-cuts at the dividing lines when the glue has set, to facilitate the painting. Glue on the feet and make a mortise in the cover to receive them.

Apply an undercoat to the box. For a novel finish, mix artists' oil color with a very small amount of varnish and apply with a coarse brush. Use uniform, vertical strokes on the box and farmer, and swirl strokes for cover, fence, and hairbrush handle. Only white oil color is needed, as any available enamel colors may be added to it for the tints. Letter the child's name on the mail box. Glue the farmer in place, and apply felt on the bottom of the box.—THEODORE TORRISON.



At left, glue overlays of paper on the farmer, then trim with a razor blade





TOY WOODEN CLOWNS CAN BE ARRANGED IN COUNTLESS WAYS

CHILDREN will be delighted with these colorful little clown acrobats because they can be put together so many ways.

Draw the design full size on paper; then trace six of the clowns on 1" surfaced pine



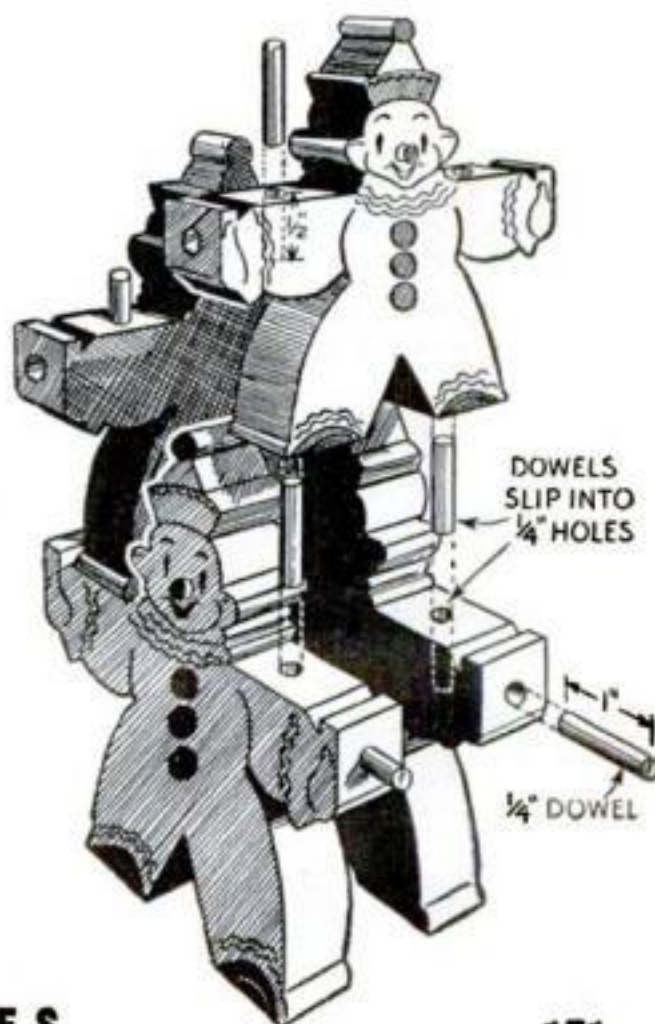
stock, and cut them out with a jig saw. Drill holes $\frac{1}{4}$ " in diameter, or slightly larger, and $\frac{1}{2}$ " deep into the hands, shoulders, and feet of each clown as shown. Next, cut several 1" pieces of $\frac{1}{4}$ " dowel. These 1" lengths of dowel are the pins that hold the clowns together when they are built up one on the other, and they must slip in and out of the holes easily. Paint the figures for added appeal. Face and hands can be white, the suit yellow, trimmings red, buttons and shoes black.—R. L. FAIRALL.

Delicate Soldering Jobs Done on Toys with an Ordinary Electric Pen



VERY small, delicate soldering jobs are easier if an electric pen is used as a soldering iron.

For example, the pen may be employed for work such as soldering a broken arm on a toy soldier, where the heat from a large iron might melt the entire shoulder away and ruin the toy.—R. B. W.



Waterproof Plywood



Resin-bonded marine plywood is the greatest single contribution ever made to amateur boat building

THE principal advantages of the new waterproof marine plywood in boat construction are the saving in labor that results from fewer seams, and the additional strength obtained in proportion to weight. It is well adapted for use as planking on many types of small, light-weight boats, and also for decking, seats, bulkheads, floor boards, and the like on all types of boats.

Only resin-bonded plywood made by the hot-press process should be used. This product is sold under various trade names and comes in thicknesses of from $\frac{1}{8}$ " to $1\frac{1}{4}$ " and in sizes up to 4' by 16'. Even larger panels may be had on special order, but the price per foot usually increases with greater than ordinary lengths.

If you are in any doubt as to the quality of the plywood to be used, boil a sample of it in water for an hour or more. This will separate the plies of anything but resin-

bonded plywood. Douglas fir is the wood most commonly used, but the panels may also be obtained in mahogany and various kinds of hardwood.

To prevent the edges of the plywood from tearing, a very fine-toothed saw should be used for cutting the panels, and the edges should be finished with a sharp plane set rather fine. Exposed edges should be sanded off round for about the depth of one ply.

Do not countersink for screw heads in fir plywood except near the edges. Drive the screws tight enough so that there is compressed wood under the bevel of the screw head, otherwise every screw hole will allow some moisture to enter the wood. Dipping the screws in marine glue before they are inserted is also a good precaution.

To prevent water-logging and protect the individual plies from the stress resulting from the tendency to expand after absorption of water, the edges of the plywood

for Boat Building

should all be sealed. This can be done with resin primer (clear resin sealer) or with aluminum paint or marine glue.

Bending of the plywood in one direction is easily done if the plywood is not too thick or the bend too great. If necessary, it may be steamed or soaked in boiling water without risk of having the plies come apart. Sharper bends may be made by making a saw cut through one ply on the concave side, at right angles to the arc of the bend. The saw cut should be filled with marine glue before the panel is fastened in position.

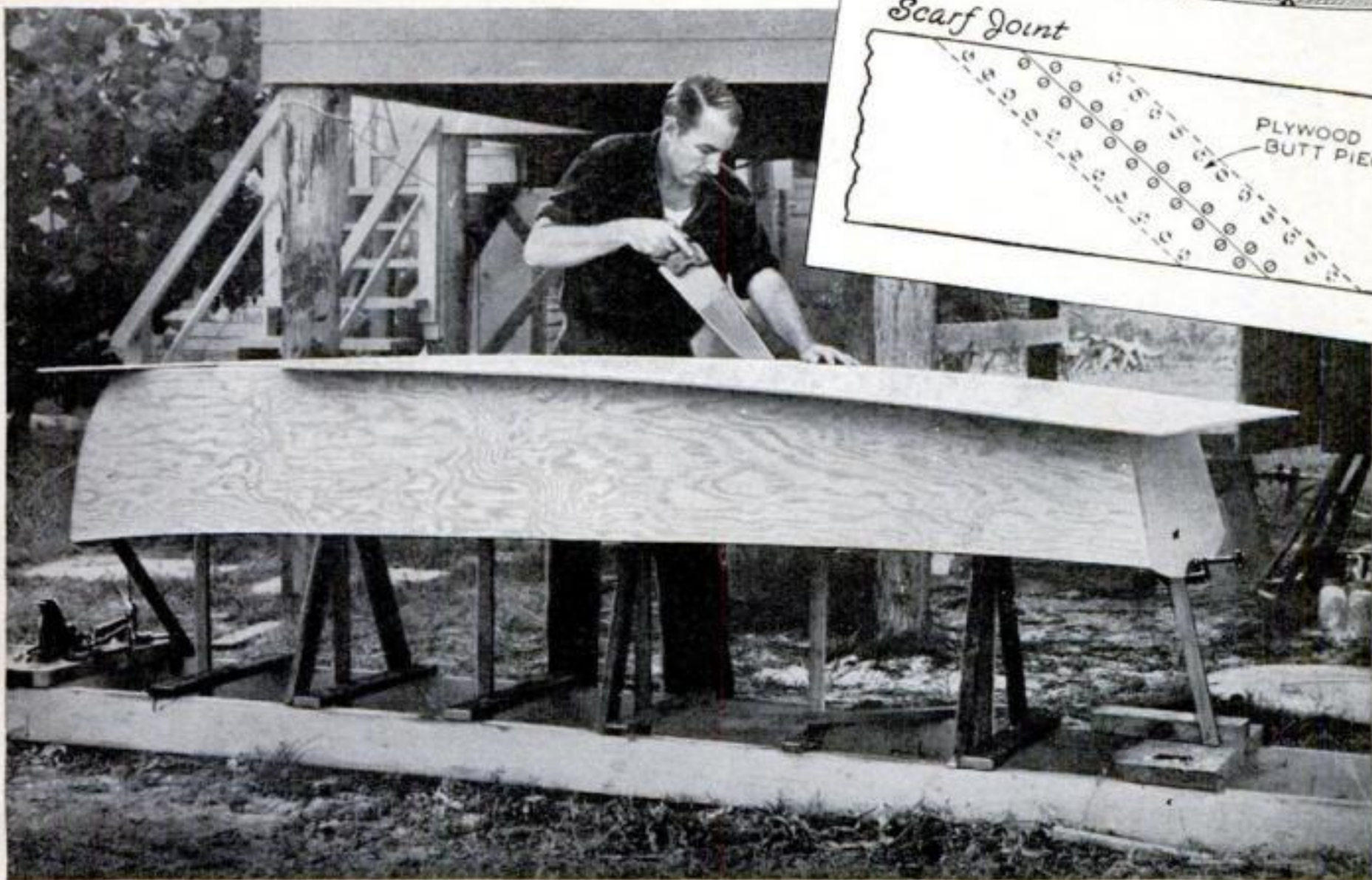
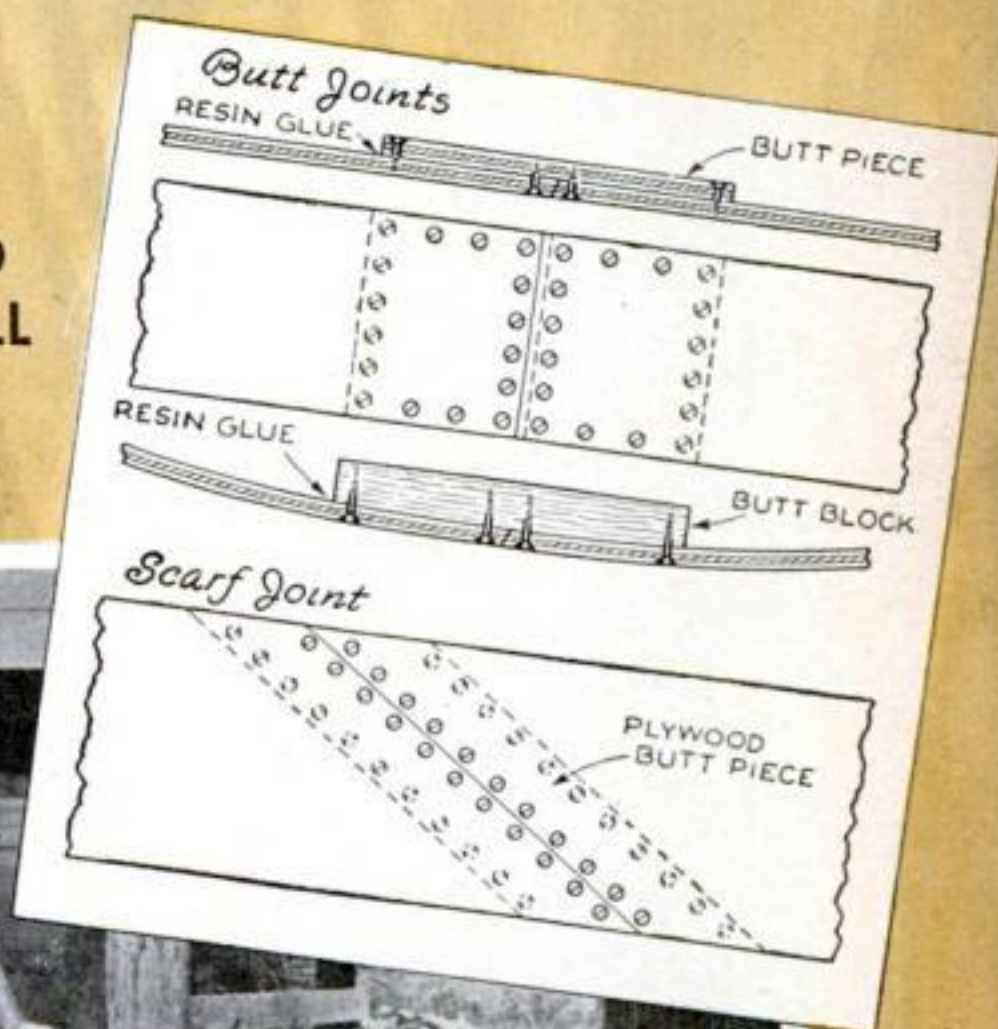
It is only with great difficulty that plywood can be forced into any sort of double bend. The amateur will find it quite difficult or impossible to make the bends necessary in a round-bottom boat, or in a V-bottom boat where there is a pronounced concave flare or concave V in the fore sections. For such purposes ordinary planking is much more suitable.

On small flat-bottom boats, the bottom as well as the sides can be in one piece. Right, how joints are made

Plywood is best adapted for planking only on comparatively short or lightweight boats, as the panels are progressively more expensive per square foot in lengths over 8'. For this reason it is often necessary or advisable in longer boats to use two or more panels to make the required length. This, of course, increases the number of seams, and the joints cannot be staggered as in the case of an ordinary planked boat. No matter how carefully made, these joints have a tendency to mar the appearance of the boat by interfering with the true curve of the sides and bottom.

It is best and easiest to use a simple butt

By
**BRUCE
and
WILLARD
CRANDALL**



joint, backed by a butt block of the same material. The planking should be screw-fastened to the butt piece along the edges close to the seam. Also screw the butt piece, along its edges, to the planking. The new resin glue (synthetic-resin adhesive) should preferably be used at such a joint. Copper rivets should be substituted for the screws if the plywood is very thin or other glue than resin glue is used.

If the splice comes at a point where there is a considerable curve in the side or bottom of the boat, it will be best to use a solid butt block, $\frac{3}{4}$ " thick or more, in place of the plywood butt piece, so that the butt block may be cut to conform to the shape of the boat at that point.

A long scarf joint may be used in place of the simple square butt joint, if desired, so as to distribute the break in the planking over a greater length of the boat, but in many cases it may cause so much waste of material that it would cost no more to use a single panel for the entire length.

The grain in fir plywood has a considerable tendency to rise and the surface to check, especially when exposed to sun and weather. This may be minimized by the use of the resin primer as a priming coat for all exposed surfaces.

Especial care should be taken with plywood boats to prevent their rubbing continuously against any object, because plywood, though very strong, is thin, and fir is a relatively soft wood. In case a hole is worn or punched in the boat, it is, of course, not possible simply to replace one plank as in other boats. The entire side or bottom will have to be replaced, or a patch made.

To patch a hole, the broken or worn part should be cut away and a similar piece fitted in its place, backed by a butt piece and fastened with screws and resin glue by the method described previously for making a splice.

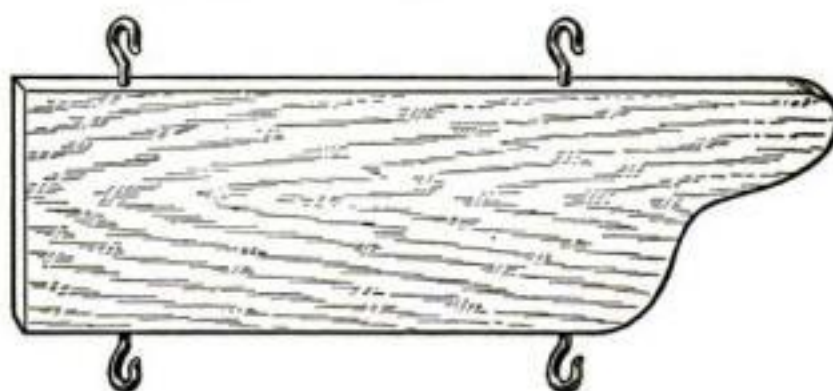
The following is a list of POPULAR SCIENCE MONTHLY boat plans published before resin-bonded plywood was on the market, which are, nevertheless, particularly well suited, for one reason or another, to the use of plywood planking. The thickness of plywood given is in accordance with the type of framework described in the plans, difficulty of the bends involved, and the requirements of weight and strength. Plywood may, of course, be used for many other parts than the planking in almost any boat.

Plan No.	Boat	Plywood Planking Thickness
131, 132, 133-R	Combination boat	$\frac{1}{4}$ " or $\frac{3}{8}$ "
147-R	Motorboat-rowboat	$\frac{1}{4}$ " with all battens or $\frac{3}{8}$ " with most battens left out
170-R	Folding duck boat	$\frac{1}{4}$ "
224-R	Utility rowboat	$\frac{1}{4}$ " or $\frac{3}{8}$ "
257-R	High-speed boat for small outboard motors	$\frac{1}{4}$ "
261, 262-R	Racing runabout	$\frac{1}{4}$ " (About half the battens may be eliminated)
281-R	Camper's utility boat	$\frac{1}{8}$ " or $\frac{1}{4}$ " (All battens as shown)
309, 310-R	Sport runabout	$\frac{1}{8}$ " (All battens as shown)
314-R	Sailboat	$\frac{1}{4}$ " or $\frac{3}{8}$ "
321, 322, 323-R	Racing sailboat Blackcat	$\frac{3}{8}$ " (Keelson or inside keel should be added)
331-R	All-purpose boat	$\frac{3}{8}$ "
339-R	Midget boat or pram	$\frac{1}{4}$ " or $\frac{3}{8}$ "
340, 341-R	Sectional rowboat	$\frac{1}{8}$ " or $\frac{1}{4}$ " (Battens can be eliminated)
344, 345-R	Fisherman's outboard boat	$\frac{1}{4}$ " (about half the battens may be eliminated)



Farm Roadside Sign Attached Between Fence Wires

FARMERS who wish occasionally to advertise produce for sale to passing motorists and tourists will find it convenient to use a signboard of the type illustrated. It is cut from an 8" board, and a pair of screw hooks are inserted in the edge at either side by which it may be quickly hooked on to two of the fence wires, or taken off, as desired.—G. E. HENDRICKSON.



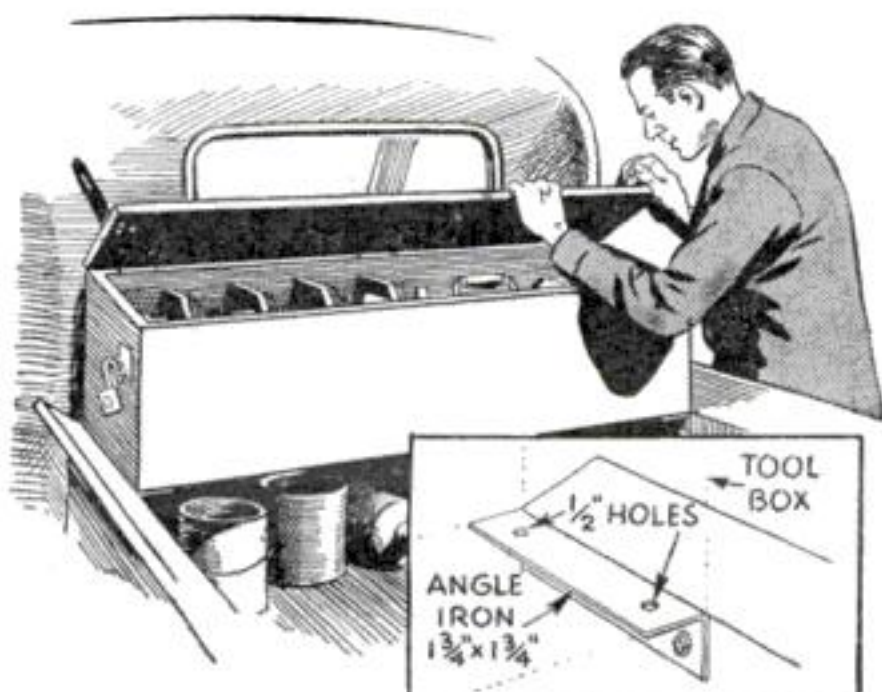


Handle on a Farm Gate Latch Makes It Easier to Open

PLAIN loops of wire commonly used for latches on farm field gates are difficult to remove or replace without pinching one's fingers, and in winter one often has to remove his gloves or mittens. To avoid this, make these wire loop fasteners with a twisted end to serve as a handle, as shown.

Large Steel Tool Box on Truck Requires No Floor Room

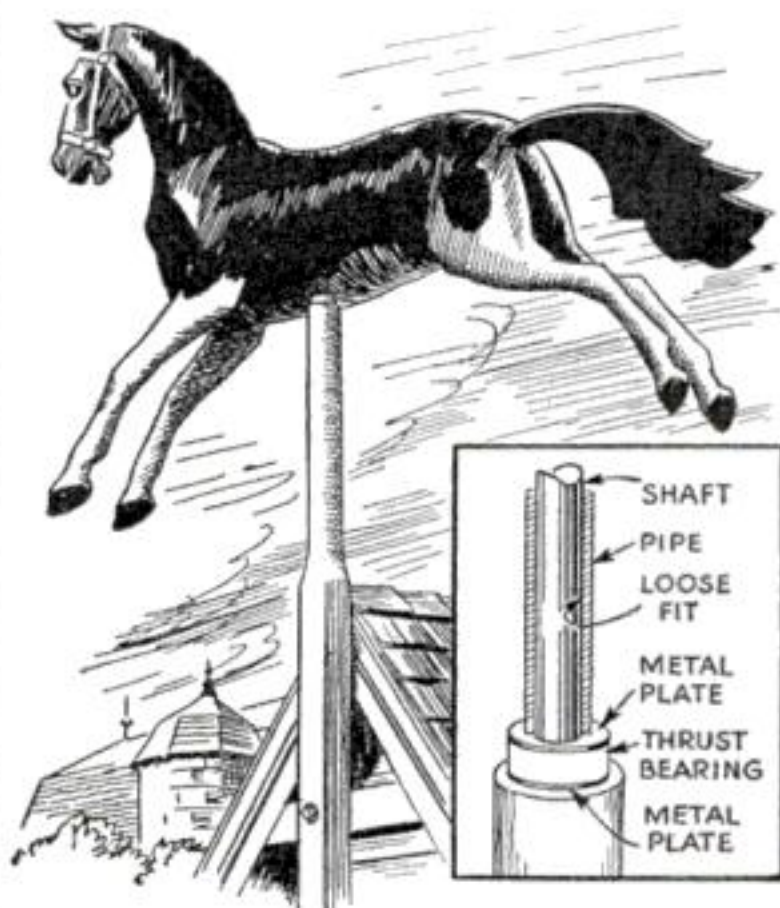
THE large steel tool box on this oil-field truck is mounted in such a way as to permit the use of the entire rack bottom. The box is fastened with $1\frac{1}{4}$ " by $\frac{1}{2}$ " bolts to the sides of the rack by means of two angle irons, as shown below. The angle irons are $1\frac{3}{4}$ " by $1\frac{3}{4}$ " by the width of the box. All nuts are in the channel of the angle iron, and suitable washers are placed under the boltheads.—JOHN LAPIN.



Discarded Toy Hobbyhorse Serves as Weather Vane

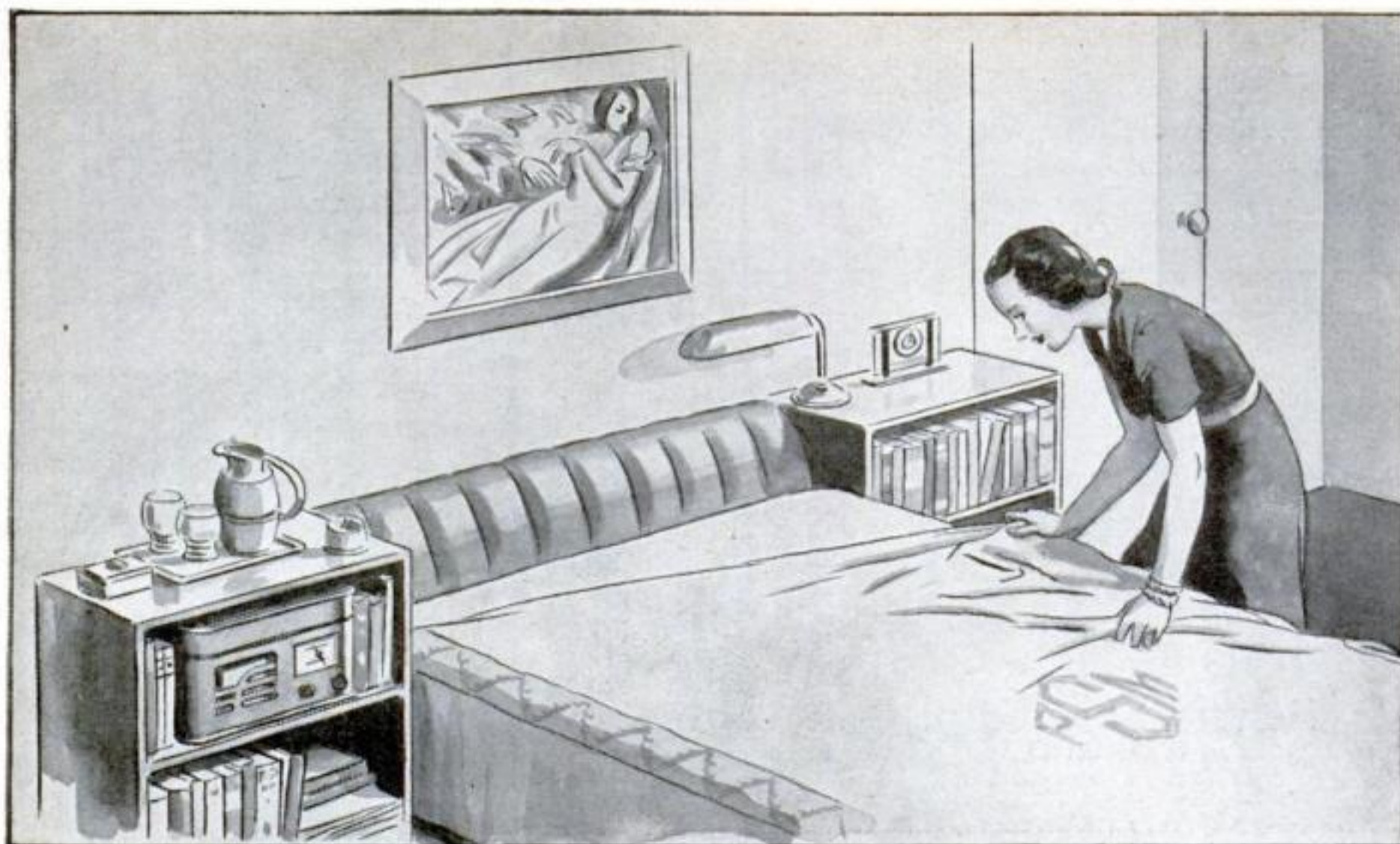
AN ORNAMENTAL and useful wind-direction indicator for a barn, stable, or any farm building may be made from a discarded toy wooden horse. This is dismantled from its rockers or wheels, and its tail, whether of carved wood or hair, is replaced with a large one made of sheet metal or resin-bonded plywood. The old paint is touched up, and realistic leather reins and brass harness fittings are added if desired.

The easiest method of mounting the vane is to insert a metal rod in the



top of the upright or staff and bore a hole to fit it rather loosely in the body of the horse. The hole should be slightly forward of the horse's center of balance. Put grease in the hole and on the touching wood surfaces.

The vane can be made much more sensitive, however, by using a junked thrust bearing mounted as shown in such a way that the ball bearings roll between two metal plates, one screwed to the horse and the other to the top of the staff. A 24" length of steel shafting of suitable diameter should then be used instead of a thinner rod. Its lower end is a driving fit in a hole bored in the staff; its upper end fits freely into a short length of pipe inserted into the horse. Cross arms with the letters N, S, E, and W may be added, if desired.—J. A. EMMETT.



Modern WALL UNITS

BY THE carefully planned use of wall units of the type illustrated, you can modernize almost any room in your home. Typical arrangements are shown for living room, dining room, and bedroom, but innumerable other combinations can be made in these and other rooms depending upon individual requirements and the space available.

Furniture stores that specialize in modern pieces offer a variety of wall units, although the prices are often disconcertingly high. Fortunately, this type of furniture is well adapted for construction in the home workshop. No great skill in woodworking is required, and a considerable saving in cost may be made. Working drawings on the following pages give the details of seven basic units.

The larger units may

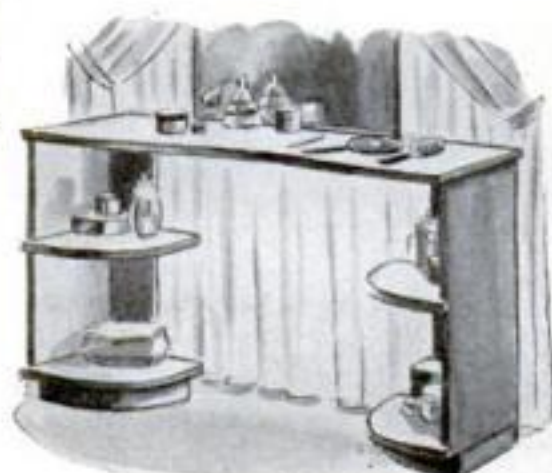
be used separately, or several pieces may be combined. If necessary, further adaptations may be made by leaving off or adding shelves to gain height, or by altering the width. When changes are made, however,

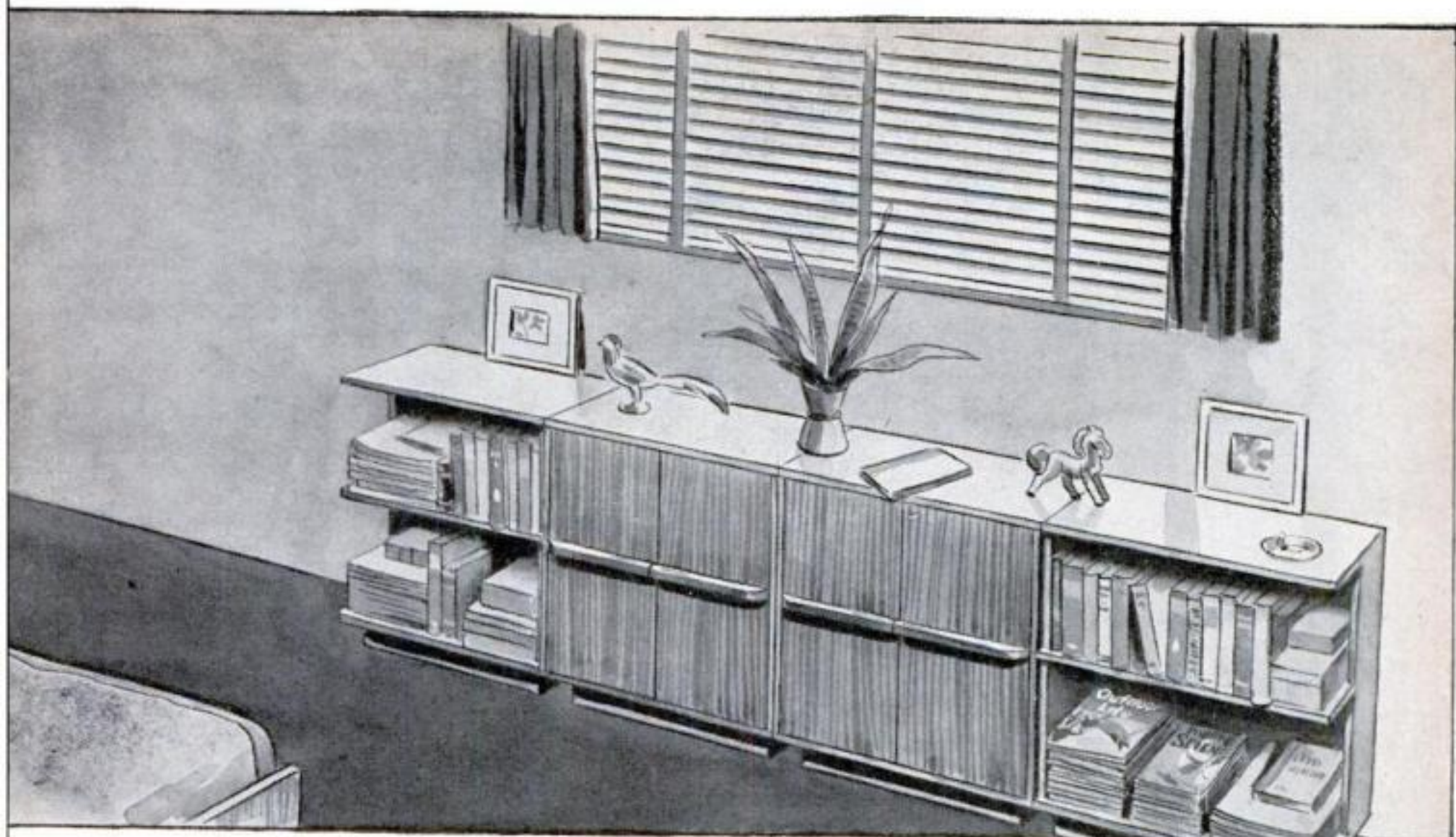
it is advisable to keep the shelf spacing as shown, as the various units will still fit together if it is ever necessary to rearrange them.

One obvious and very great advantage of these units is their portability. They can be taken with you when moving and adapted to suit a new home, and this is something which cannot be done with built-in furni-



Two of the end units 28½" high can be converted into either a desk, as above, or a girl's dressing table, as at right, by adding a 1½" top. At top of page, how the wall units can be distributed in a room to enhance its attractiveness



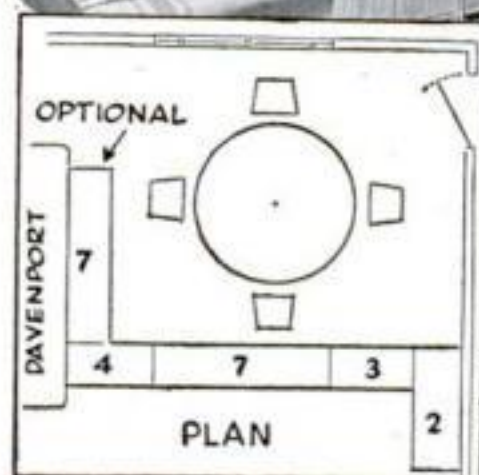


WILL REMAKE ANY ROOM IN YOUR HOME

ture. Nevertheless, the design details have been worked out to produce a built-in effect no matter what combination of pieces is selected. The continuity of the horizontal shelf lines is a factor in obtaining this effect, and it will be noted that even the long horizontal handles of the doors are spaced to form an unbroken line.

Modern furniture of this type allows a wide choice of woods. Birch is excellent because it is hard and takes a good finish whether the pieces are to be stained to match dark trim or walnut or mahogany furniture, or are to receive a lighter and more modern blond treatment. Redwood is a soft, easily worked wood that does not warp readily and can be obtained in wide boards at reasonable cost. Plywood has many advantages and may be used throughout, in which case the exposed edges should be concealed by gluing on a solid strip.

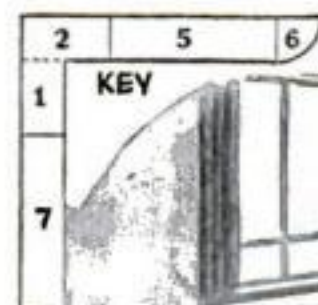
For ready identification, the units have been numbered. The first and second are similar except for their width; and the third is like the others except in height, which is one shelf less. Furthermore, these units may be built right- or left-handed, as required. The fourth design contains a closed cabinet, and, like the fifth cabinet, forms an excellent center unit of a group. Supplementary



Dining Nook

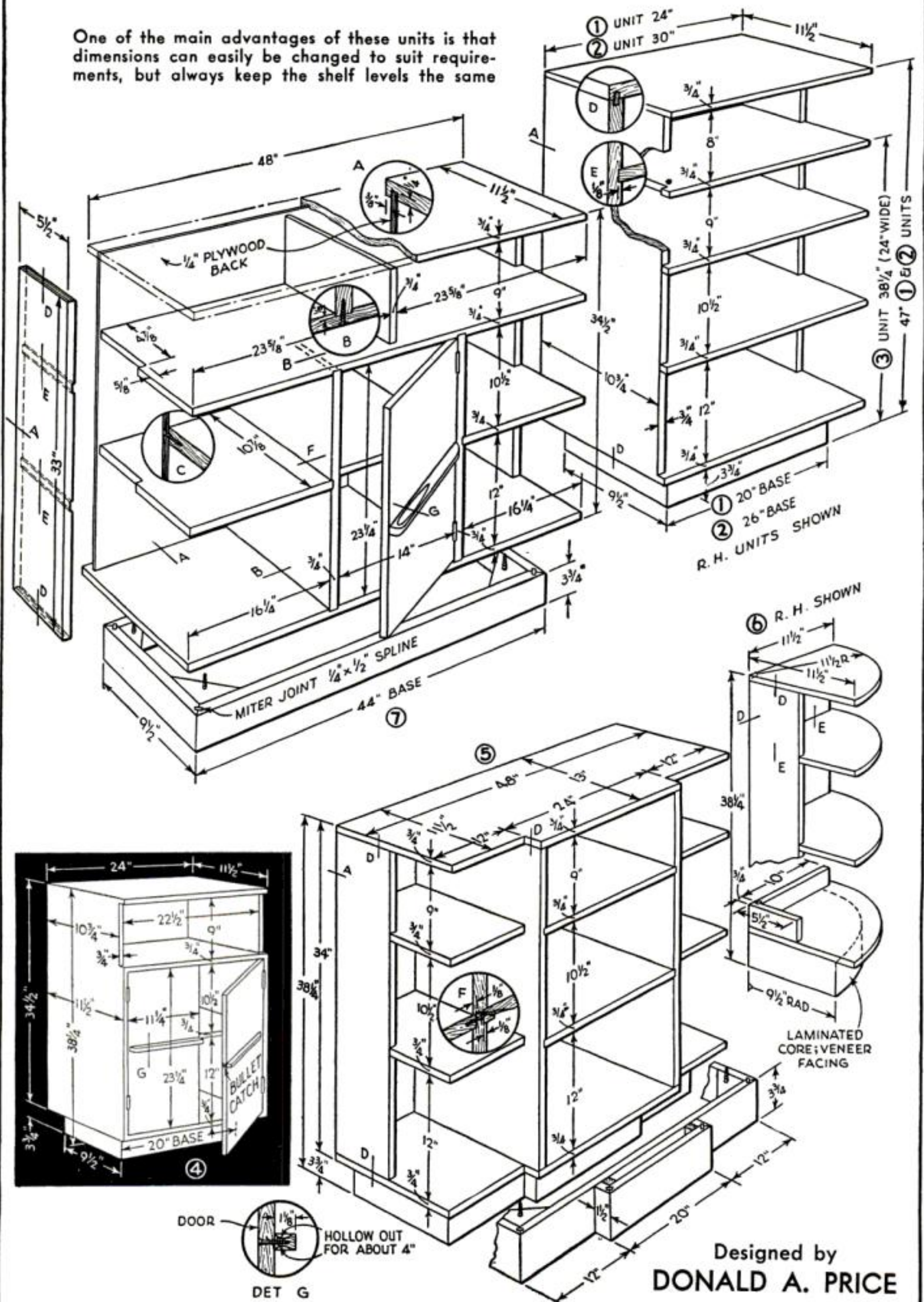


Buffet



Library Corner

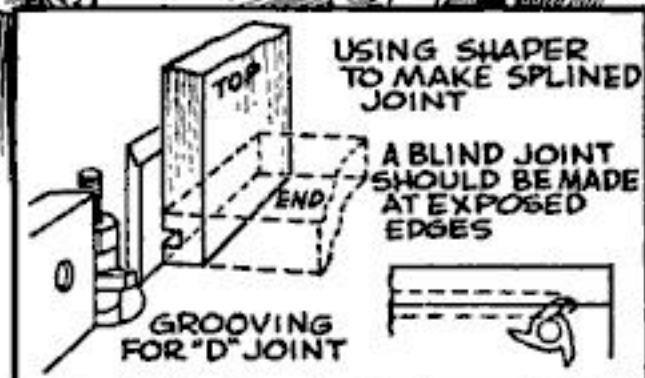
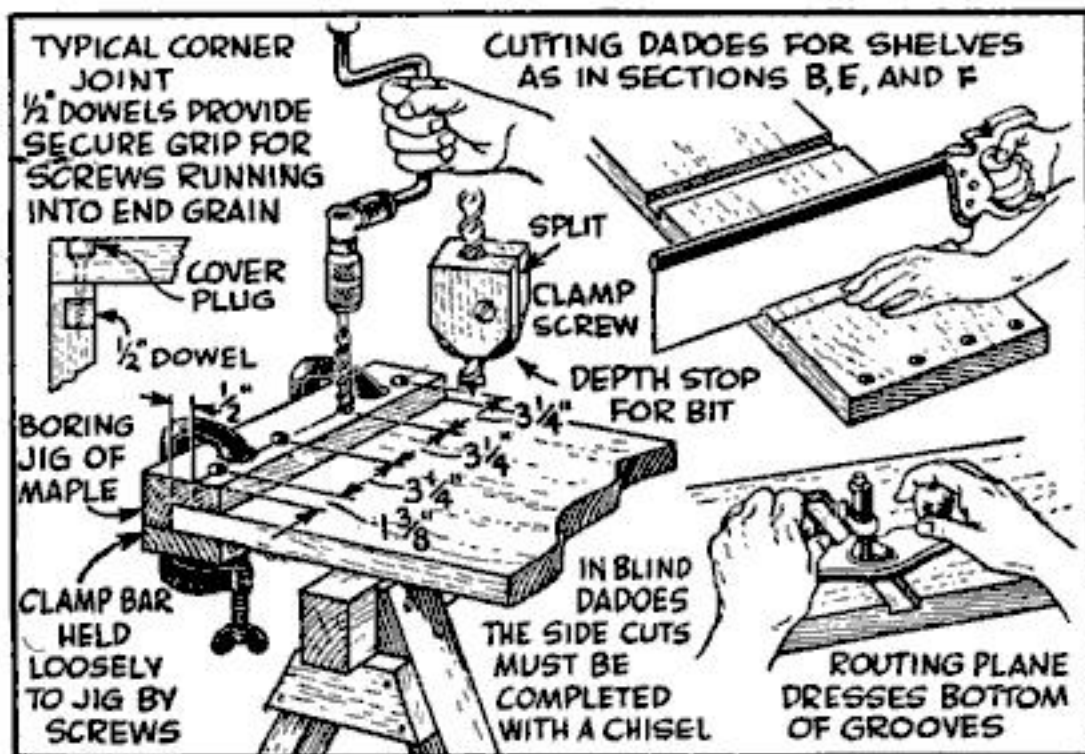
One of the main advantages of these units is that dimensions can easily be changed to suit requirements, but always keep the shelf levels the same



What the Materials Will Cost You

Unit No.	Bd. Ft. Lumber	Sq. Ft. Plywood	Cost in White Pine or Redwood	Cost in Birch or Maple
1	18	8	\$3.00	\$4.60
2	21	10	3.40	5.30
3	15	6	2.55	3.90
4	18	6	2.90	4.50
5	30	12	5.20	7.90
6	11	—	2.10	3.40
7	30	12	5.20	7.90

These estimates include from 50 to 75 cents for finishing, and a small allowance has been made for nails, screws, and glue. Softwood is figured at 11 cents and hardwood at 20 cents a board foot; plywood at 5 cents a square foot. Before building any combination of the units, make out a consolidated list of materials to insure economy and avoid waste.



Grooves for the splined joints can quickly be cut with a shaper. For angle cuts a simple jig is required. At top, using circular saw and jig

Left, dados for shelves may be cut with a handsaw and finished with a router. Use a jig for boring holes, and a stop block on the bit

to these is the sixth design, which is a small end unit that may be placed anywhere. The seventh cabinet is another wide, substantial piece with a central compartment closed by a single door.

The upper shelf of the fourth design might be eliminated to make a lower cabinet, if it is desired to break the top level of a line of units. The fifth and sixth designs, if treated this way, would be ideal for use under a window.

The type of joints to be used will depend upon the experience of the builder and the equipment available. Various suggestions are given in the drawings and sketches. Even a handy man who has little more equipment than a household tool kit can do a good job of building this type of furniture if he takes great pains with the finishing

and is careful to conceal, as far as possible, all traces of "hammer-and-nail" construction.

Where woodworking machines are available, the $\frac{3}{4}$ " thick stock can be dadoed very quickly for the shelves, mitered joints can be freely used, and grooves cut for splines as suggested in the sketches. For example, a wooden jig can be made and used for cutting the spline joints on a spindle shaper as illustrated, or the same jig can be adapted for use on the circular saw by extending the base slightly to form a stop for the work.

Detailed instructions for finishing furniture have been given in previously published articles and summarized in the painting section of the POPULAR SCIENCE MONTHLY Shop Data File.

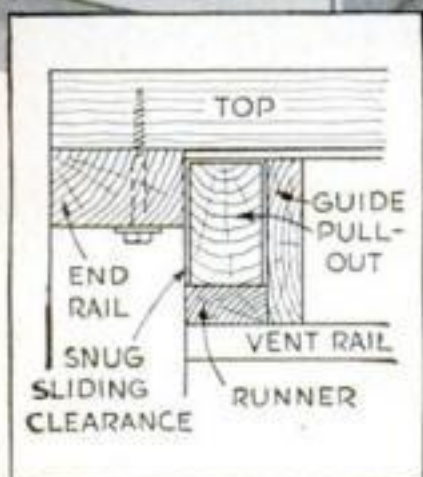
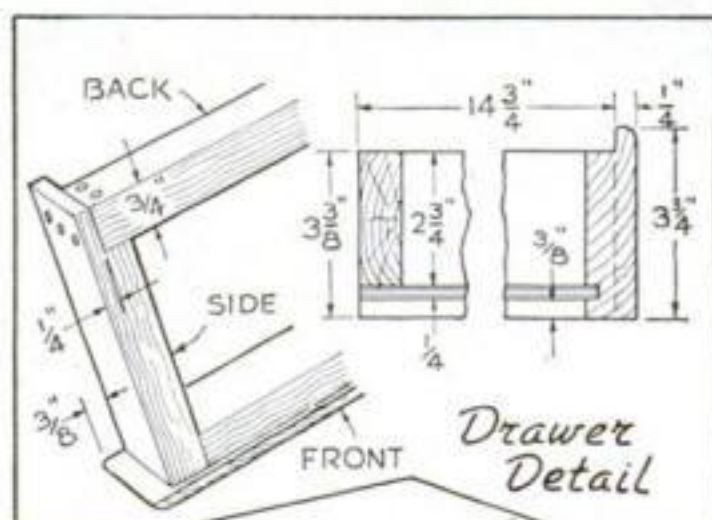
Space-Saving Cabinets



By removing the belt from the pulley, the lathe mounting can be swung open to form a table top 25" by 48"

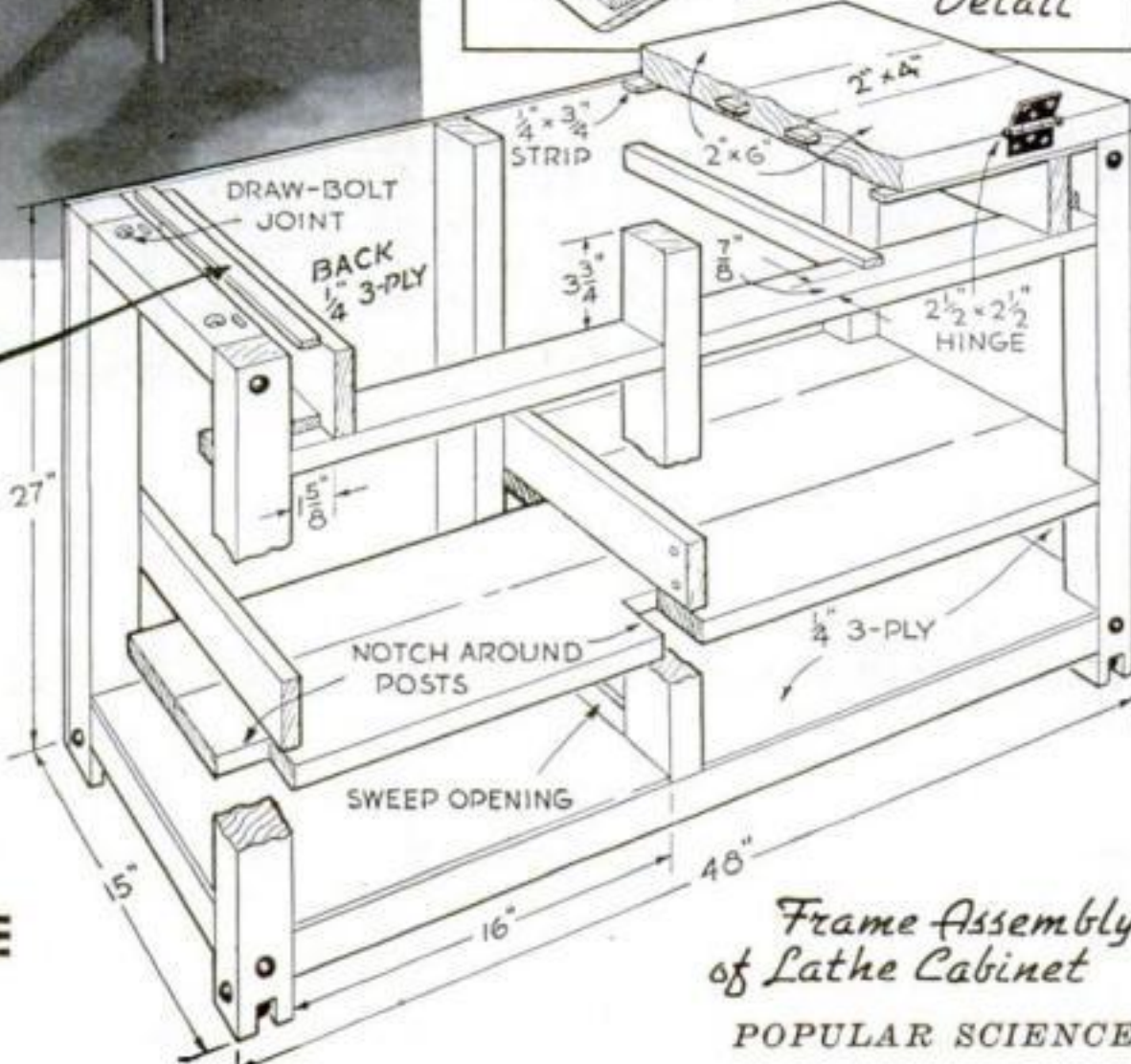
WELL-DESIGNED, carefully built cabinets are important in the home workshop from the standpoint of convenience, neatness, and space economy. Take the time to study your own shop layout and plan cabinets that will hold the tools and materials where they will be most accessible.

As an example, we illustrate this month the lathe cabinet designed for the shop of my young friend, Robert Jaacks. This cabinet, besides storing all accessories near at hand and providing a rack for turning squares in the bottom, has an ingenious arrangement for mounting the lathe. A hinged leaf



How the framework is constructed for the cabinet shown above. On the facing page is a detail of a rack for holding turning chisels

By **EDWIN M. LOVE**



*Frame Assembly
of Lathe Cabinet*

POPULAR SCIENCE

for the Home Workshop

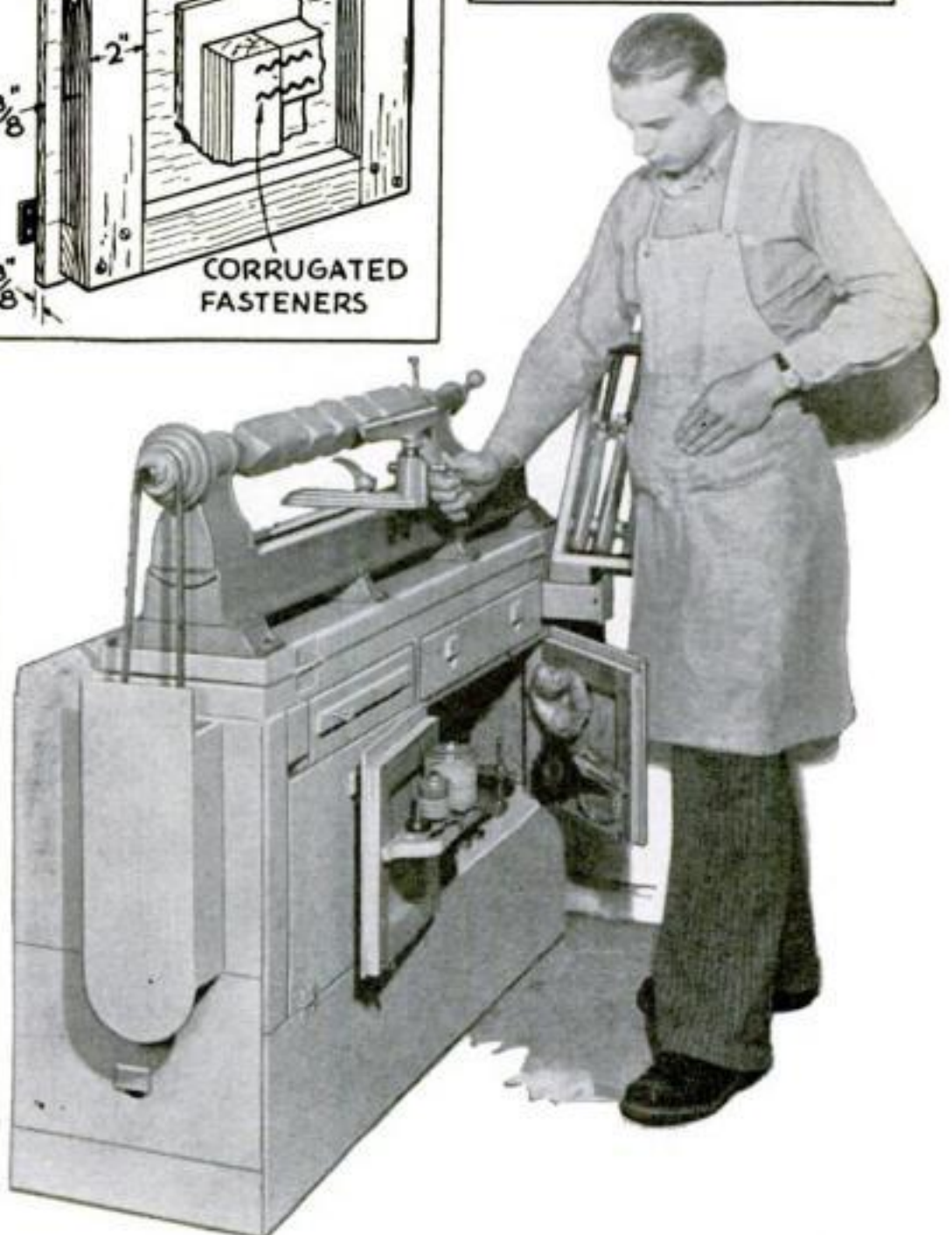
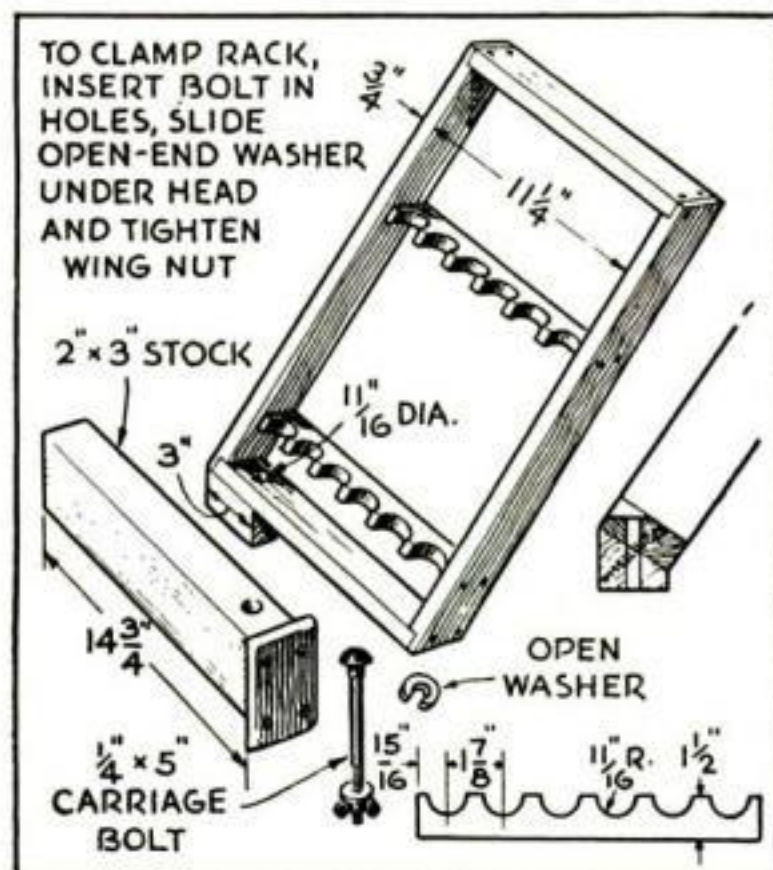
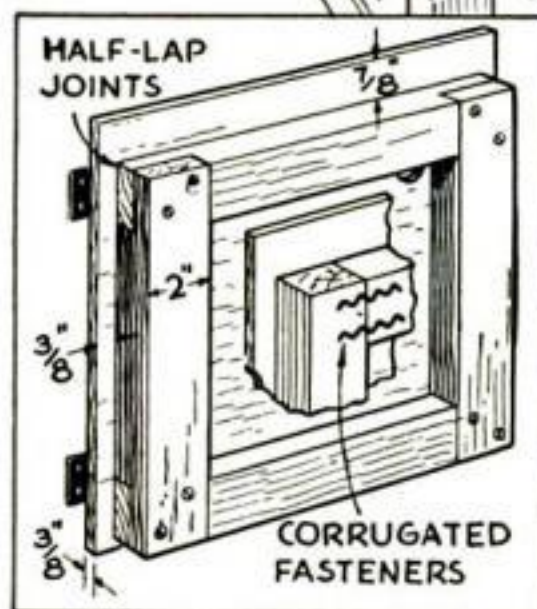
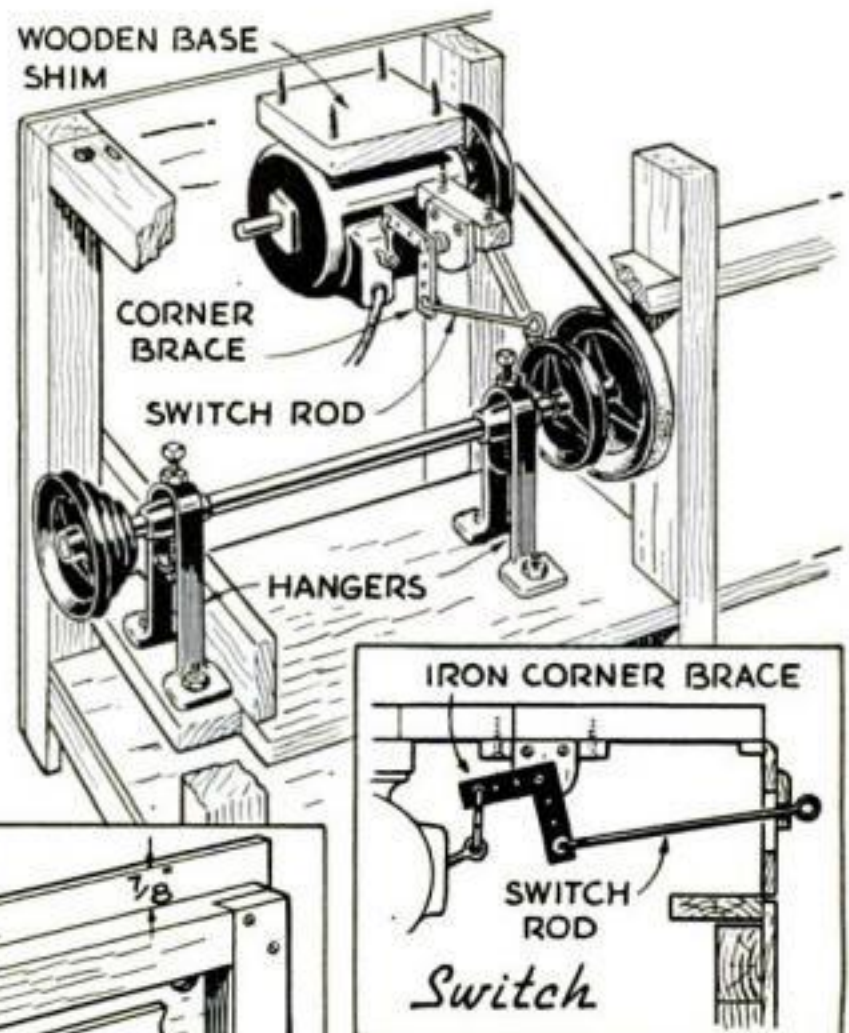
is provided to hold the lathe, and this opens out to form an unobstructed table top 25" by 48". Such a table can be used in many ways in a shop where floor space is at a premium.

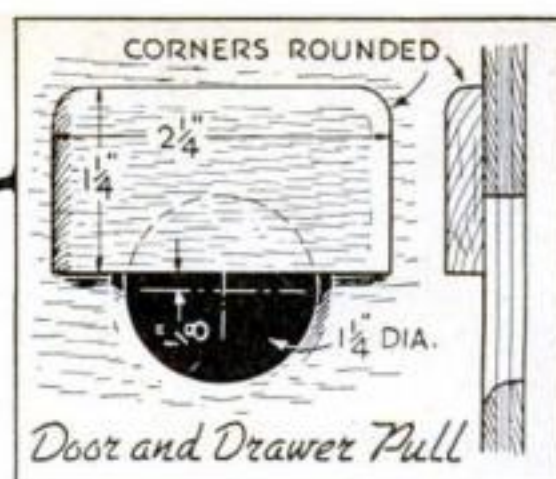
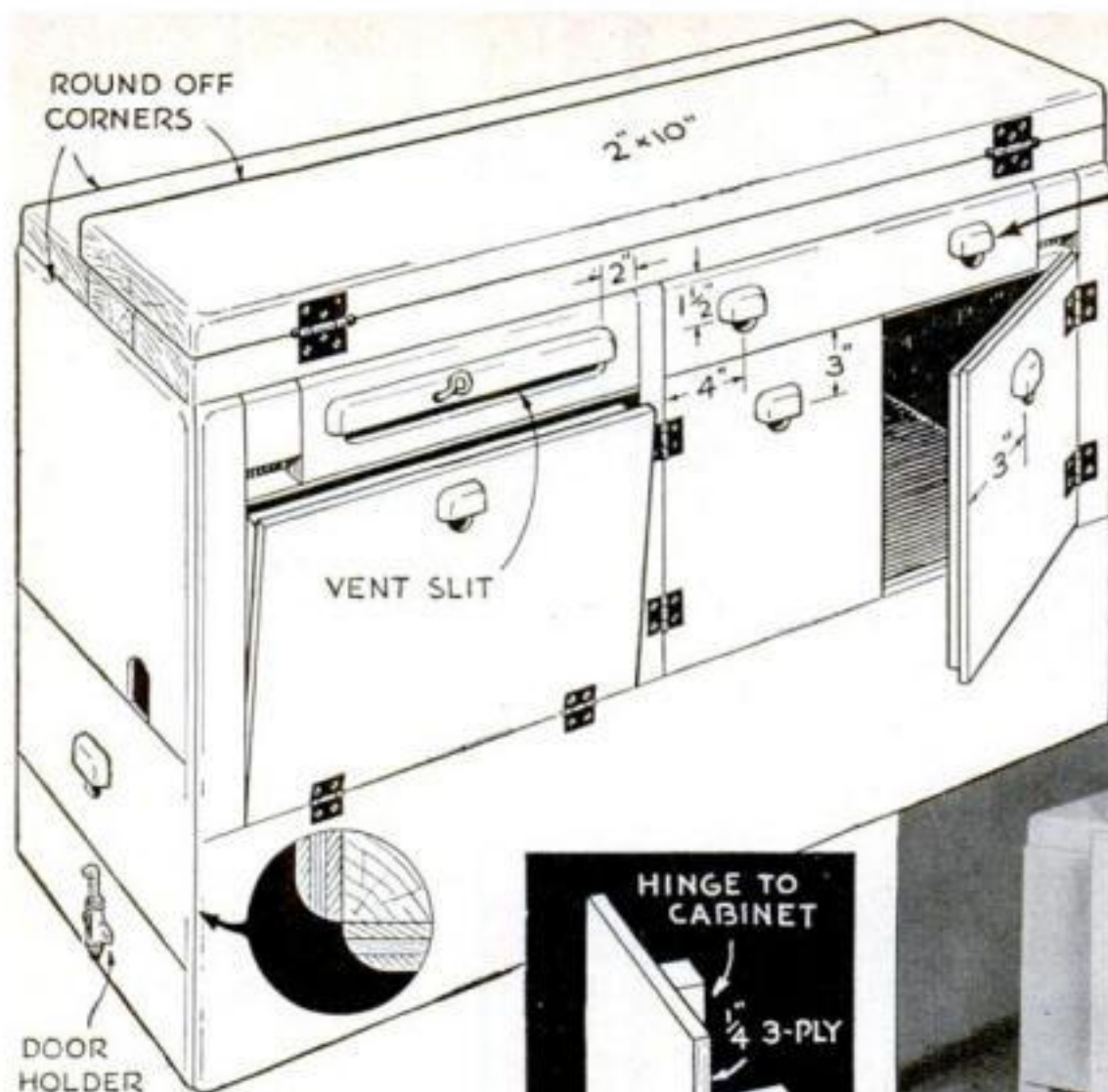
The turning chisels are kept in a rack that sheds off shavings. For use, it is lifted from the drawer and bolted on a pull-out bar at the right end of the cabinet. If the outboard turning of large parts has to be done, the rack is fastened on a bar at the left end.

This cabinet can be fitted to almost any home-workshop lathe, a change in length being the only major alteration required. The materials needed are listed on the next page.

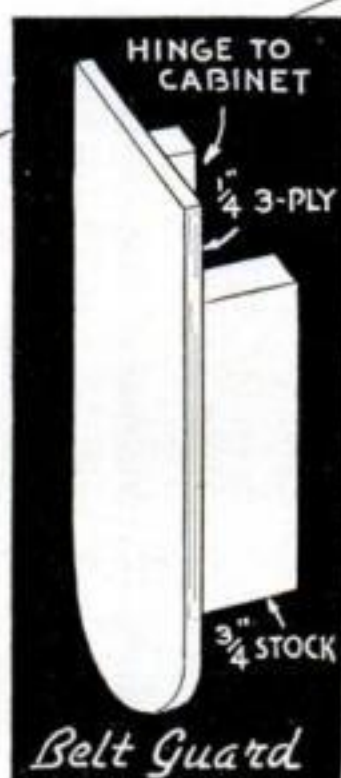
The top pieces may be butt-glued, with several corrugated fasteners driven into the underside. However, slip-tongue joints are easily made with a dado head on the saw. Make grooves $\frac{1}{4}$ " by $\frac{1}{2}$ " in the edges, cut a $\frac{7}{8}$ " plywood strip across the grain, and glue it in the slots. While the top dries, cut the frame parts and bolt them together.

Plane the undersides of the top at the ends to seat them on the rails, and attach with lag screws having washers under the heads. Draw up the center screws tightly, but leave the outer ones slack





Sketch of completed cabinet. At extreme right, storing turning squares in the lower compartment



enough so that the top can slide when it shrinks and swells. As less movement takes place at the middle, the uprights at that point can be spiked through the top and lower rails. Nail $\frac{1}{4}$ " strips under the top at the edges and above the drawer sides and pull bars. Toenail the drawer and vent rails, and nail in runners and side guides for the pull bars.

The floor boards are plywood, supported by cleats in the center, where the opening facilitates sweeping out and inserting a screw driver for attaching the motor shelf. The height of the latter is determined by the belt.

Hinge the lathe plank to the top with the hinge joint sunk halfway, so that the plank will lie flat. Set the lathe on top and loop the belt over the pulley to locate the motor height. Screw the shelf cleats to the uprights to suit, or, if the shelf would be so high as to limit storage space unduly, drop it and block up the motor.

If a countershaft is used, screw the shelf temporarily, stand the countershaft as near the front as possible, and locate the motor under the top according to its belt length. If necessary, block it down. A detail drawing shows a simple method of operating the

LIST OF MATERIALS

Part	No.	Size	Length
Top	2	2"x6"	S4S 48"*
"	1	2"x4"	" "
"	1	2"x10"	" "
Corner posts	4	2"x3"	" 27"
Center "	2	"	" 23"
Front and back rails	2	"	" 47"
End rails	4	"	" 12"
Drawer and vent rail	1	1"x3"	" 48"
Pull-out bars	2	2"x3"	" 15"
" guides, cleats	6	1"x4"	" 15"
Runners	3	1"x2"	" 15"
Shelf	2	1"x6"	" 48"
"	1	1"x4"	" 28"
Doors	6	1"x2"	" 13"
"	2	1"x2"	" 40"
Drawer front	1	1"x3 1/4"	" 24"
" sides and back	1	1"x4"	" 54"
Sheathing †	2	1/4"x48"	27"
"	2	1/4"x15"	27"
Bottom shelf and drawer bottom †	1	1/4"x15"	74"
Hinges — 4 pr. 1 1/2"x1 1/2", 1 pr. 2 1/2"x2 1/2".			
Four friction catches; 1 1/2" flathead screws; 6—1/4"x2 3/4" lag screws; 8—1/4" carriage bolts, 3 1/2" long, 4—4 1/2" long, and 4—3" long, 1—5" long; 16-penny spikes; 3/8" corrugated fasteners; brads; 4-penny finish nails.			

* Allow extra for length of toppieces.

† Sheathing, bottom shelf, and drawer bottom are fir three-ply wall board. All other parts may be pine or fir.

switch with a pull rod through the vent. An iron corner brace pivoted on a wooden support serves as a bell crank.

Carry the motor cord out behind the



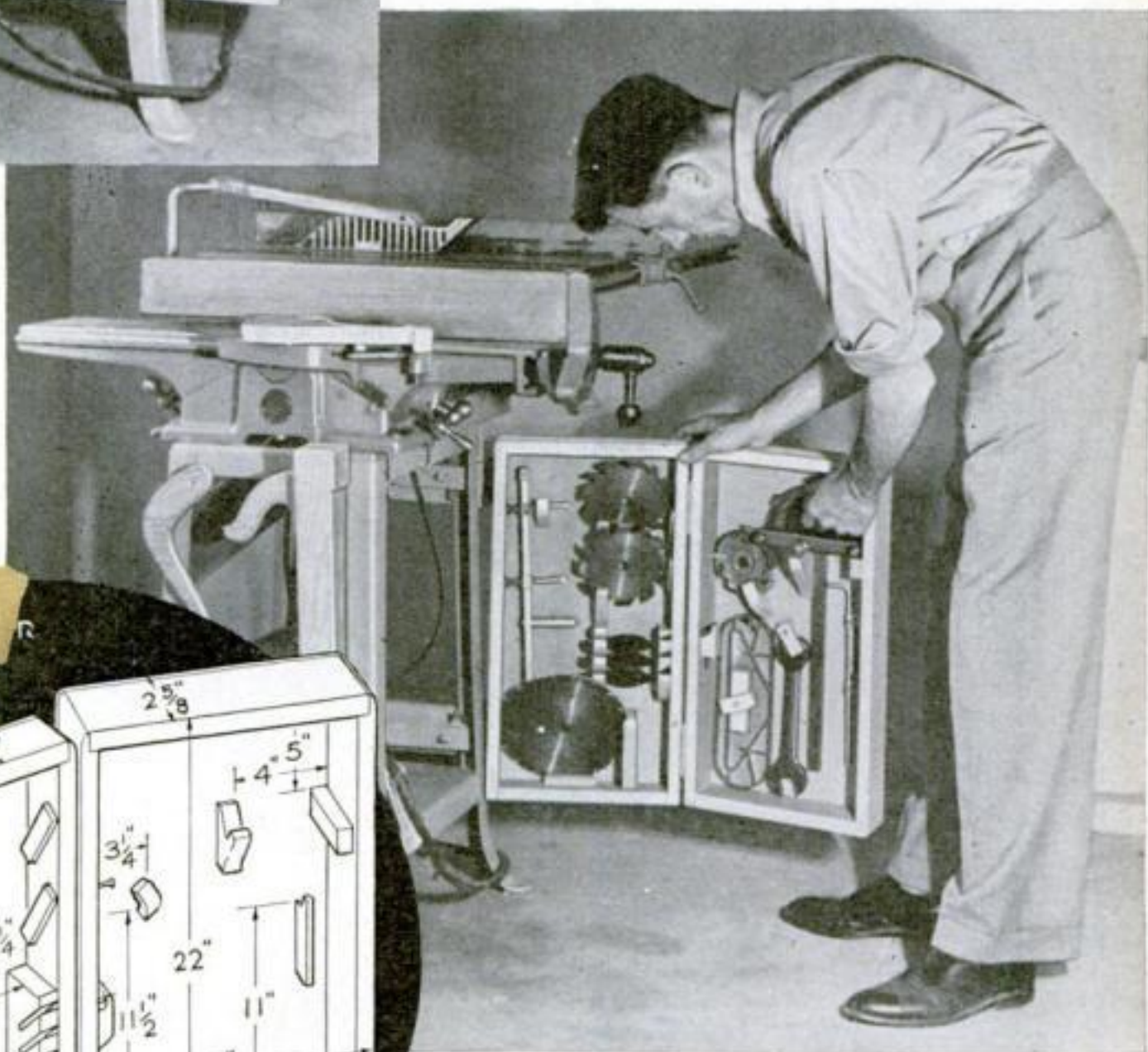
The accessory cabinet folds back behind the saw, where it is held against cleats by a turn button, as demonstrated above

drawer rail and through a hole in the right end. If it is too short for this method, mount an outlet at the end for plugging in the cord. Attach a heavy extension cord permanently to the outlet, with a plug at the other end to connect to the circuit.

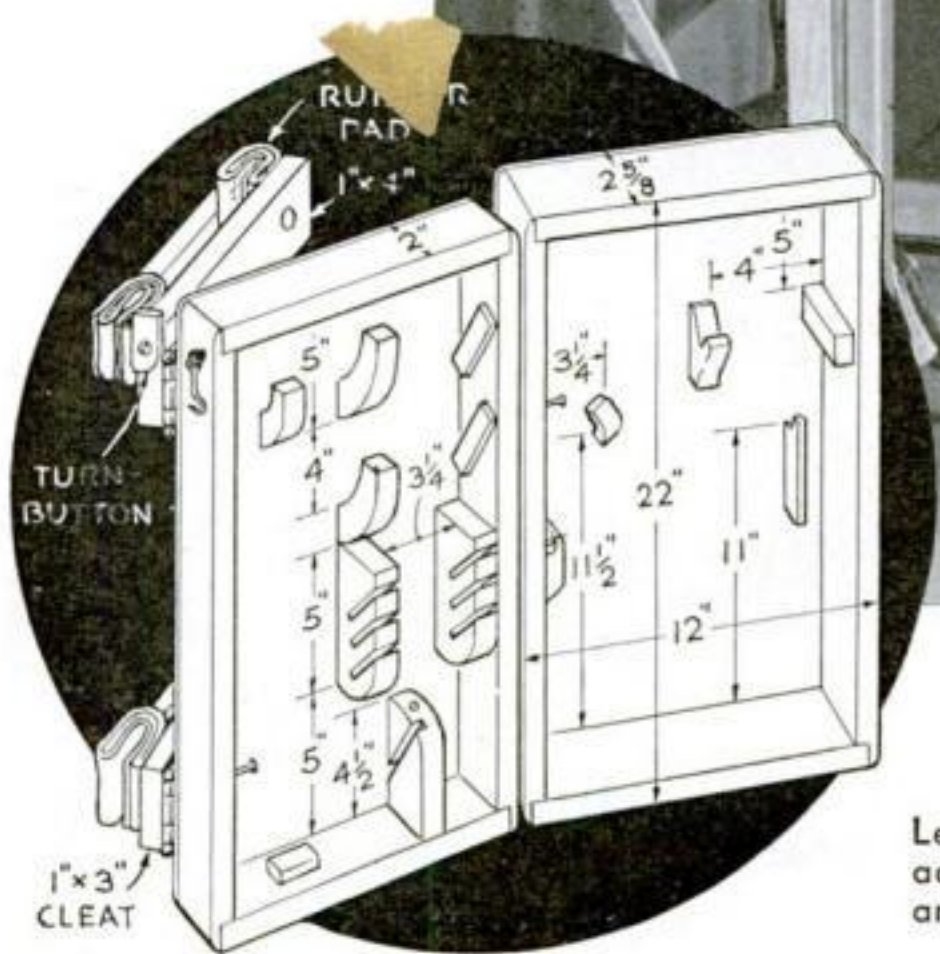
The plywood sheathing in front must be cut so there will be a $\frac{1}{4}$ " projection of shelf edge and stiles (posts) for forming door stops. Build the door frame about $\frac{3}{16}$ " smaller than the openings, and glue and brad the plywood in place, fitting it with $\frac{1}{16}$ " clearance all around. The end door has two lugs glued to the back of the upper edge to catch behind the sheathing, while the lower is held with a friction catch.

Make the ventilator and nail it in place. Build the drawer with $\frac{1}{4}$ " side and $\frac{1}{8}$ " vertical clearance. Put it in place and scribe a pencil line on the bottom at each side of the runner, to align $\frac{1}{4}$ " guide strips. Fit the ends of the front and round the top edge to conform to the sheathing.

Fit the pull-out bars rather snugly, covering the front ends with plywood blocks, which should be glued and nailed, and fitted



Above, nearly all standard circular-saw accessories can be stored in this cabinet, which is hinged to cleats on the saw stand



Left, alterations can be made to suit the accessories if necessary. Note that saws are mounted at an angle for easy removal

to the openings like drawer fronts. The open space beneath provides finger room.

The drawing of the chisel rack is self-explanatory.

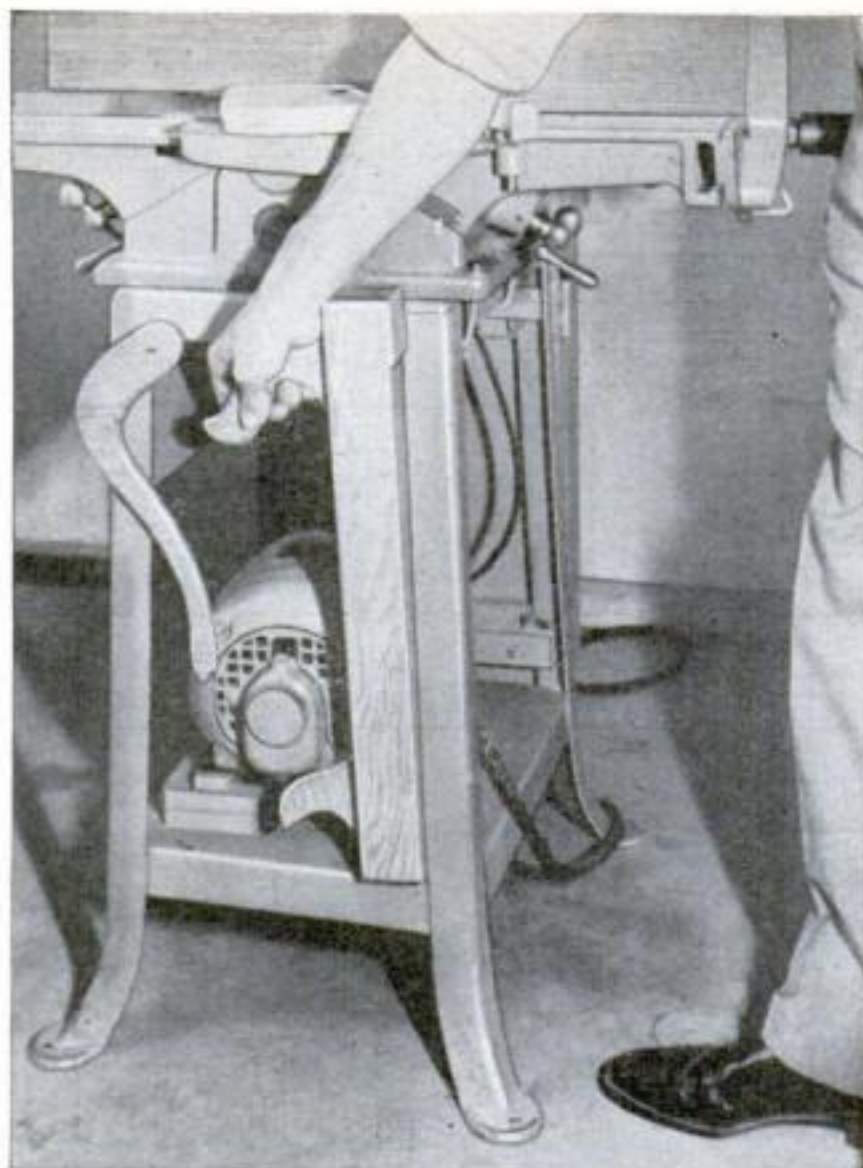
Roller-skate wheels make cheap and durable casters. They enable the cabinet to be jockeyed into place with little effort. A rubber-tipped door holder screwed to each end and snapped against the floor will prevent creeping when the lathe is in use.

To support the weight of the inverted lathe, clamp a piece of 1" pipe in the tool holder. Plug the lower end with wood and press on a crutch tip.

A saw cabinet is also illustrated. It folds back unobtrusively against the stand, but swings out instantly into the clear when open. The dimensions fit almost all standard saw accessories, but alterations may be made to suit the builder. The saws, being mounted at an angle, are easy to remove. The double cleats, which are bolted to the saw stand (whether of the pressed steel or the cast variety) with rubber liners to prevent drumming, provide hinge space. A hook and eye lock the cabinet shut, and a turn button on the end of the top cleat, above the hinge, holds the cabinet back against the cleats when it is turned.

On steel stands, push sticks can be handily hung beside the jointer. The jointer pusher, or mitten, has a hole in the front end and a sloping one in the side near the back end. The first slips over a bolt end put in the shelf near the edge; the second catches a bolt passed through a hole drilled in the top flange and bent upward at 45 deg.

The push stick for the saw hangs from another bolt through the rim of the top.



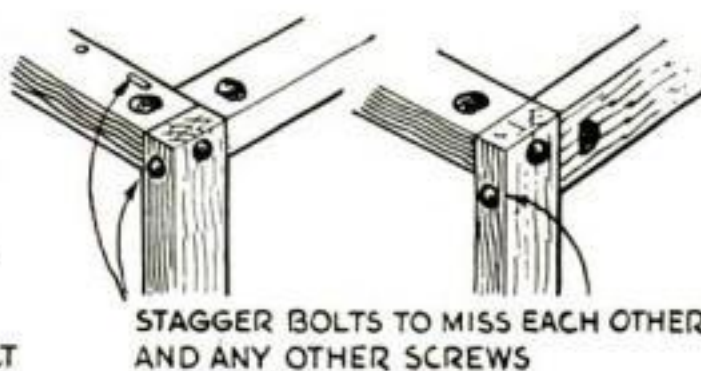
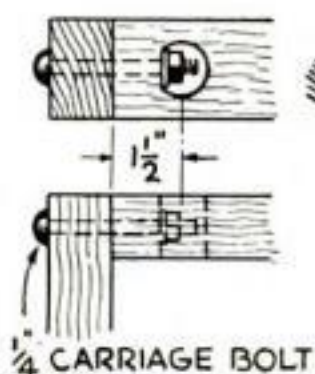
An upward and outward motion lifts the jointer push stick, or mitten, from the bolts on which it hangs

Robert Jaacks has begun the second year of his home workshop by arranging a down payment of \$12 on a set of chisels and a wood-turning lathe of 11" swing. The monthly payments will be \$6 out of his budget of \$15 a month. He also paid \$4 down on a used 1/3-h.p. repulsion-starting motor, to be paid for in three months.

DRAW-BOLT JOINTS

[WOODWORKING]

This joint is simple, quickly made, and capable of being tightened from time to time to take up slack due to shrinkage. It is used mainly in 2" or thicker stock, for bench construction or other heavy framing. 1. Square stock for the joint. Gauge center line on width of rail and stile near joint end. 2. Gauge center lines, for thickness and width, on end of rail. Gauge across stile center line from the end. 3. Bore 1" hole through rail thickness, or nearly through, centered 1 1/2" from end. Chisel out a flat seat for the washer. 4. Bore 1/4" bolt hole through stile, and from end of rail into large hole. Bolt hole in stile may be counterbored to sink head flush. (A dowel may be used each side of the bolt, if desired, to prevent any possible twisting of the joint.) 5. Put 1/4" carriage bolt through stile and far enough into rail end to start nut on, with washer underneath. Turn up nut until slack is taken up.



POPULAR SCIENCE MONTHLY SHOP DATA FILE

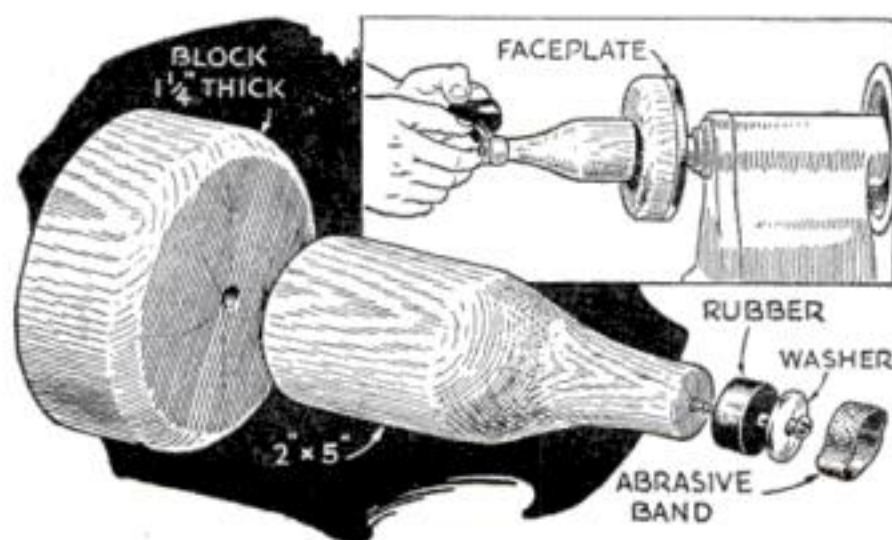


Holes in Bench Under Drawers Eliminate Need of Pulls

DRAWER pulls are usually in the way at the front of a workbench. They can be eliminated by cutting a half-round hole through the front board of the bench just below each drawer. This gives a convenient grip on the bottom lip of the drawer.—E. W. L.

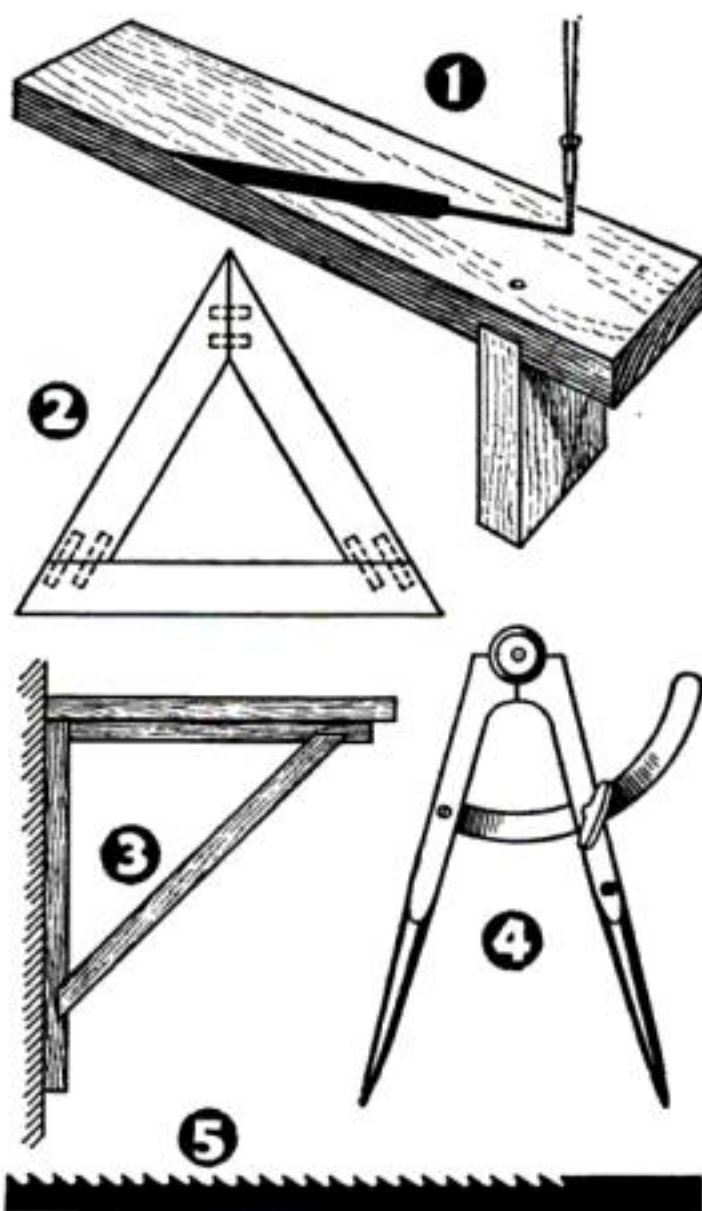
Sanding Spindle for Shaping and Finishing Small Work

THE sanding device, shown below, for shaping and finishing small pieces of wood or plastic is patterned after a spindle used by a dental technician. Both block and spindle are roughed out separately, then trued and finished after being assembled. The rubber cushion, cut from one or more thicknesses of a discarded rubber heel, holds the sanding band firmly when compressed by tightening the end screw. Excellent small abrasive bands can be obtained from dealers in hand-motor grinding tools and from dental supply houses.—R. F. HUTCHISON.



What's Wrong? IN THESE SKETCHES?

WHAT errors can you detect in the accompanying sketches? The first is a method of reinforcing a dado joint, the second a dowel-jointed triangular frame, the third a shelf brace. In the fourth drawing is shown a pair of wing dividers, and the fifth is a scroll-saw saber blade. The list of mistakes is printed below, upside down.

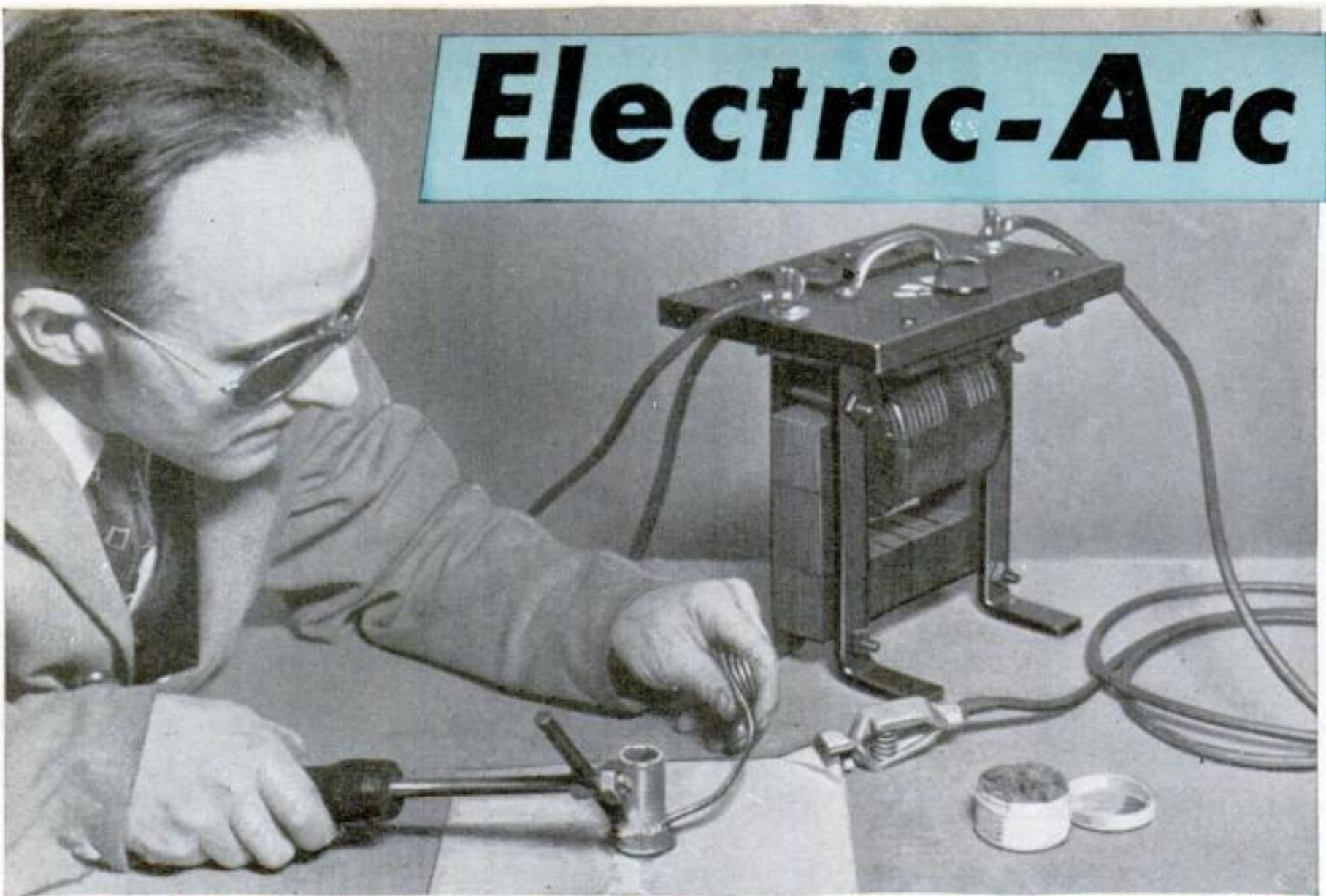


1. The screw driver, as shown by the shadow, is too large for the size of the screw and will mar the surface of the work. 2. Assembly is impossible. 3. The horizontal member of the brace should be nailed on top of the vertical piece. 4. The crotch of the dividers is already closed so the points could not be adjusted any closer together. 5. The teeth face in the wrong direction.

Nail Used to Drive Cross Screws

WHEN the new type of so-called "cross screws" have to be driven or removed and the proper driver is not available, it is often possible to use a twenty-penny nail with its head filed or sawed off. Insert the nail in a small hand drill. The point, being more or less diamond shaped, fits into the head of the cross screw.—RAY WHITTON.

Electric-Arc



Soldering two pieces together. The work is placed on a clean sheet of metal to which the ground clamp has been fastened. The wire solder is merely trailed along behind the white-hot carbon point

ANY shop doing light metal work or experimental work and model making, as well as garages and battery shops, will find this electric-arc soldering and lead-burning outfit extremely useful.

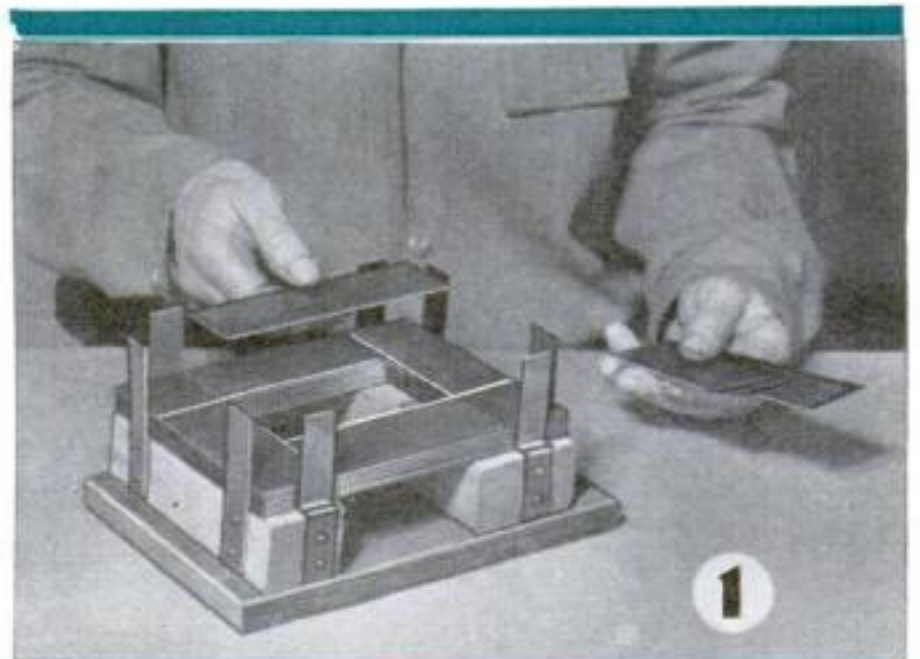
The main unit is a step-down transformer, which lowers the usual 110-115 volt alternating current to a selection of four lower voltages and gives the necessary high amperage. The core is made from common sheet stovepipe iron, obtainable in almost any sheet-metal or plumbing shop. While silicon steel is the usual material for transformer cores, stovepipe iron is much easier to get and almost as satisfactory.

The windings, as shown in the drawings, consist of 318 turns of No. 14 single-cotton, enameled wire for the primary, which lies on a 4" winding space. There are 53 turns to a layer, and six layers. This coil is tapped after being wound on the form at the 159th, 212th, and 265th turns. With the full 318 turns, these taps give four secondary voltages controlled by a four-point switch.

For the secondary winding, 16 turns of D.C.C. flat wire, 0.225" by 0.130", which is 7/32" by 1/8", are wound in each of two layers. The ends are connected in parallel to form a single heavy winding of 16 turns.

This could be placed on the opposite leg of the core as it is often done, but there will be less core loss and greater efficiency if it is wound on top of the primary with good insulation between the two.

If difficulty is experienced in obtaining the flat wire, four regular No. 8 round wires could be substituted. Allow 16 turns to a layer, but wind four layers, connected in parallel at their ends. Another possible



The form for stacking the core consists of a baseboard, two blocks, and eight iron strips

Soldering

Part One
By HAROLD P. STRAND

source of heavy wire is the field windings of some types of auto starting motors, which can be picked up in auto graveyards. This flat wire may not be the same size as specified, but if it is not so thick, more layers can be put on to obtain the same cross-sectional area.

A special feature of this transformer, which will be interesting to those who take photographs, is a built-in receptacle with its wires so connected that the four-point switch acts as a rheostat and enables ordinary 110-115 volt lamps to be stepped up in voltage to make them burn as photoflood lamps. This is done by making the primary serve for an autotransformer. Use only the first three steps of the switch.

This transformer is designed for use only on 60-cycle current. On lower frequencies the winding would be the same, but considerably more iron would be required in the core, which would also take more copper.

The first step is to obtain the sheet iron and have a tinsmith cut it up on his foot-power shears. The pieces are all $1\frac{3}{4}$ " wide. Half of them must be 6" long and half 4". Enough pieces will be required to make a rectangular stack $1\frac{3}{4}$ " thick when tightly compressed. This gives a cross-sectional area to the core of 3.06 square inches.

The core laminations are stacked as shown in Fig. 1. By alternating the positions of the pieces in each succeeding layer, joints of one layer are covered by the next. Edges must butt tightly together.

Compress the laminations tightly with hand screws or clamps until $1\frac{3}{4}$ " thick. In this case a large hand screw (Fig. 2) was used with C-clamps at the sides. A band of friction tape is applied at three sides. Then a hammer and a block of wood are used to drive

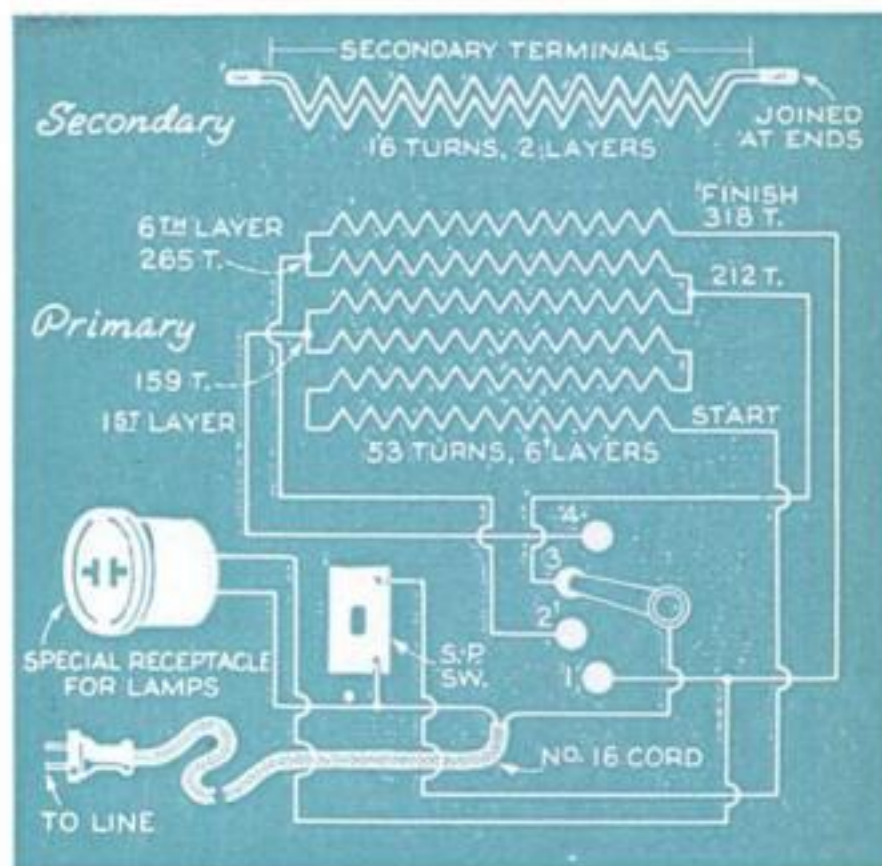
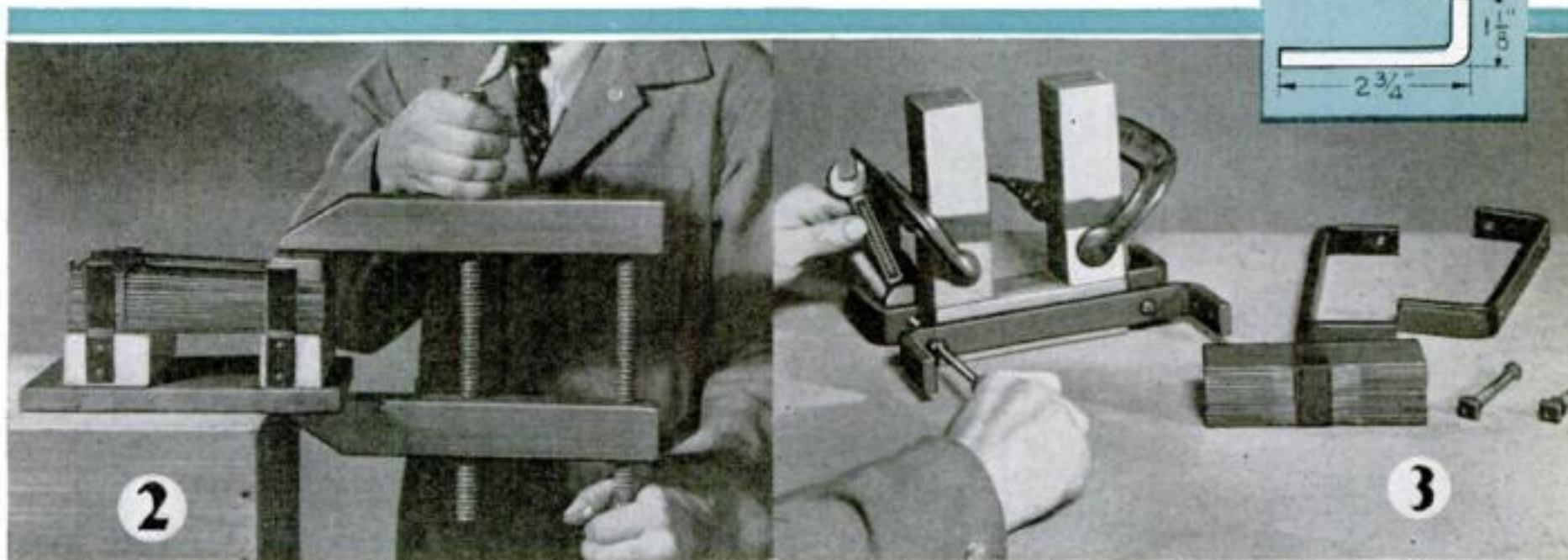
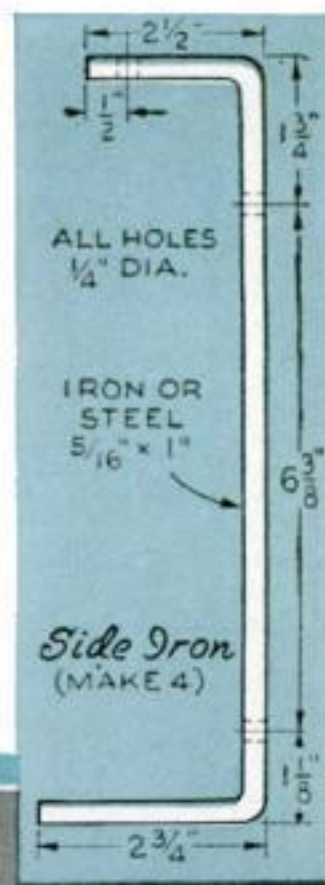


Diagram of primary and secondary coils and their connections. The primary taps are carried to a four-point switch. Right, a leg



Compressing the stacked pieces of the core with a hand screw. The final thickness should be $1\frac{3}{4}$ "

Two of the legs or side irons are clamped on, and one end section is removed until the coil is ready

all the joints together and true up the stack.

The core is now removed from the large hand screw, and two of the side irons are attached as in Fig. 3. These irons are made

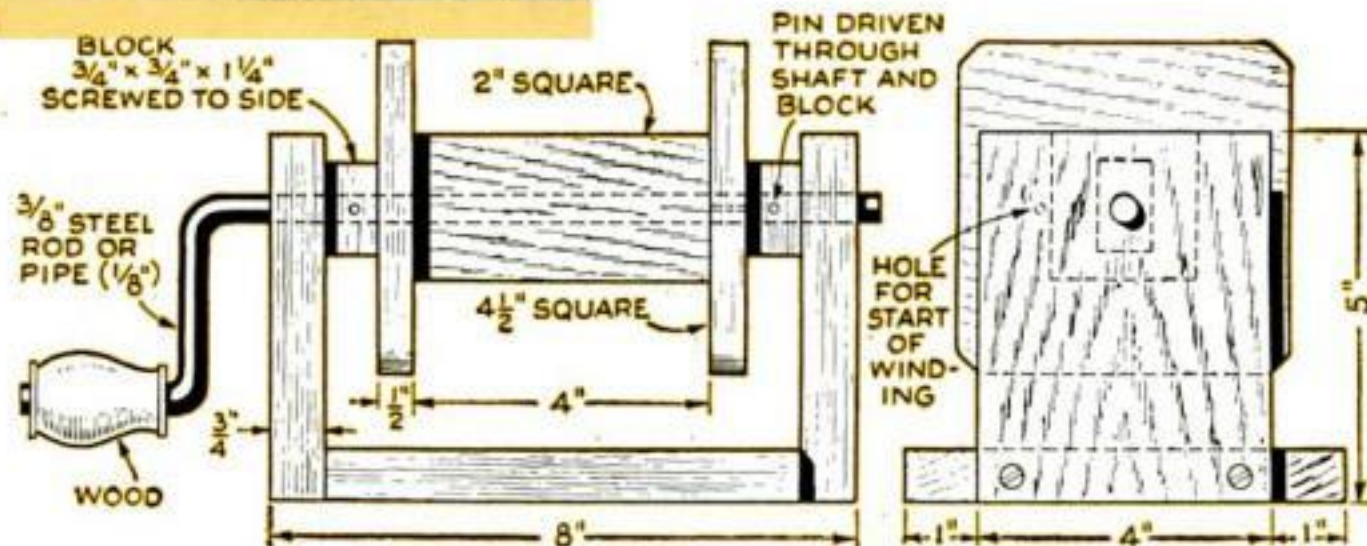
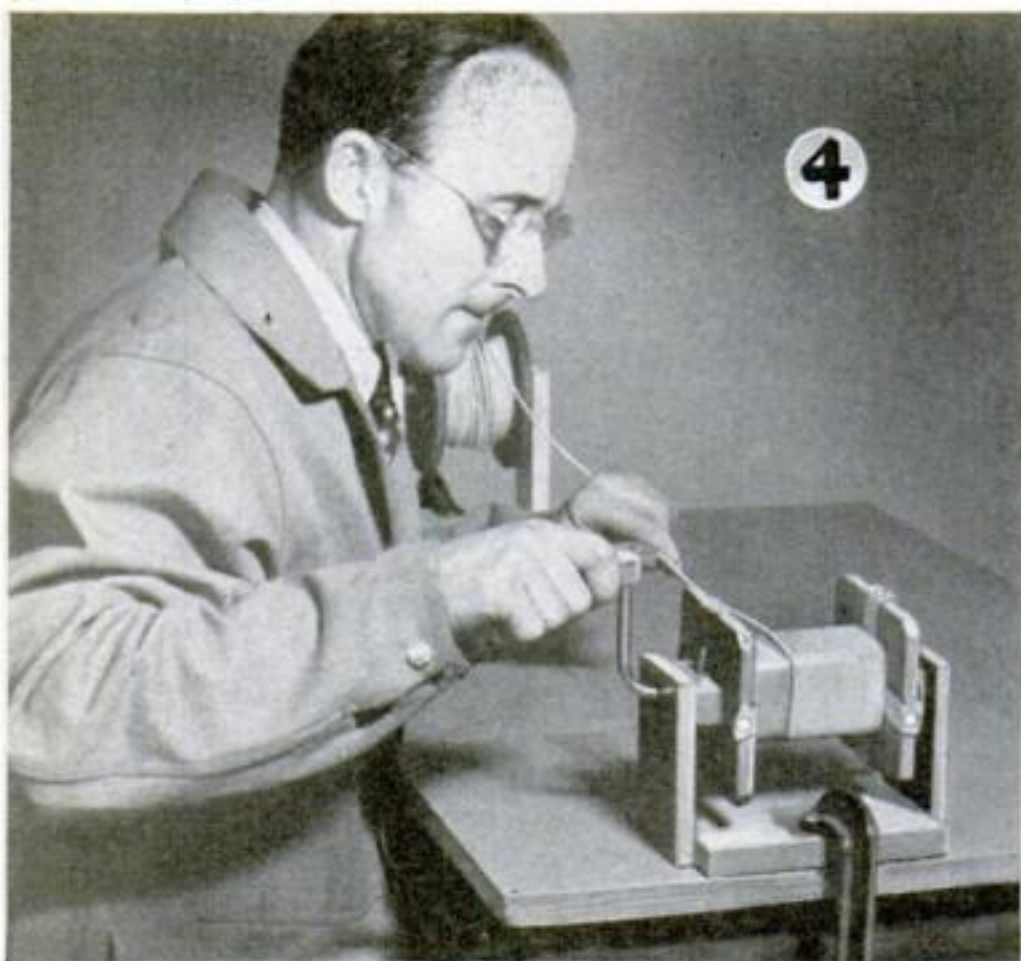
as shown in the drawings from 1" by 5/16" soft steel or iron. They can be bent to shape in the vise after being heated to a cherry red. The end section of the core is next removed by lightly tapping it out with a hammer and a block of wood.

The form for winding the primary should be carefully and very strongly made as detailed in the drawings. It must be capable of withstanding the force used in pulling the wire tight so as to form a neat, compact coil. Place four pieces of cotton tape (not friction tape) on the square center part of the core and wrap over them four layers of varnished cloth. A single band of friction tape will hold these in place for the time being. The ends of the tapes can be kept out of the way while winding by using thumb tacks into the form sides (Fig. 4).

Wind the turns carefully, keeping them tight and close together. The 53 turns will just fill the 4" space. Apply a layer of varnished cloth and continue until six layers are wound on. This will take about 3 1/2 lb. of the No. 14 S. C. E. wire.

In Fig. 5 the winding has been completed, and the tapes are being tied so the coil will stay in shape while it is being removed from the form. The latter is now taken apart by removing the necessary screws, and the coil can be pressed off the center part of the form.

The next step is to tap the primary turns with some No. 16 flexible wire. This has been done in Fig. 6. The idea is to cut out one complete layer of 53 turns with each turn of the switch, so we go to the opposite end of the coil from the finish end and make the first tap there. This will be on the 265th turn. Scrape a short space in the wire until very clean. Take a piece



Start and finish of the primary winding. The cotton tapes are tied tightly to hold the coil in shape. The form for winding the coil is made as at right

of very thin brass or copper and make a sort of sleeve around the turn and the bared end of the flexible lead. This is then well soldered.

Going back again toward the finish end, we tap the second layer down on this end, which is on the 212th turn. Returning to the other end again, the third layer down is tapped, or the 159th turn. Also solder some flexible wire to the start and finish ends of the winding. Mark all leads with tags for later identification.

The next step is to wrap a small, square piece of varnished cloth around each splice and replace the cotton tapes one at a time with friction tape, allowing the tape to go over the joints to bind them down tightly. Figure 6 shows this work. Note the relative positions of the taps, with the start and finish ends at the bottom and the other taps above at each end.

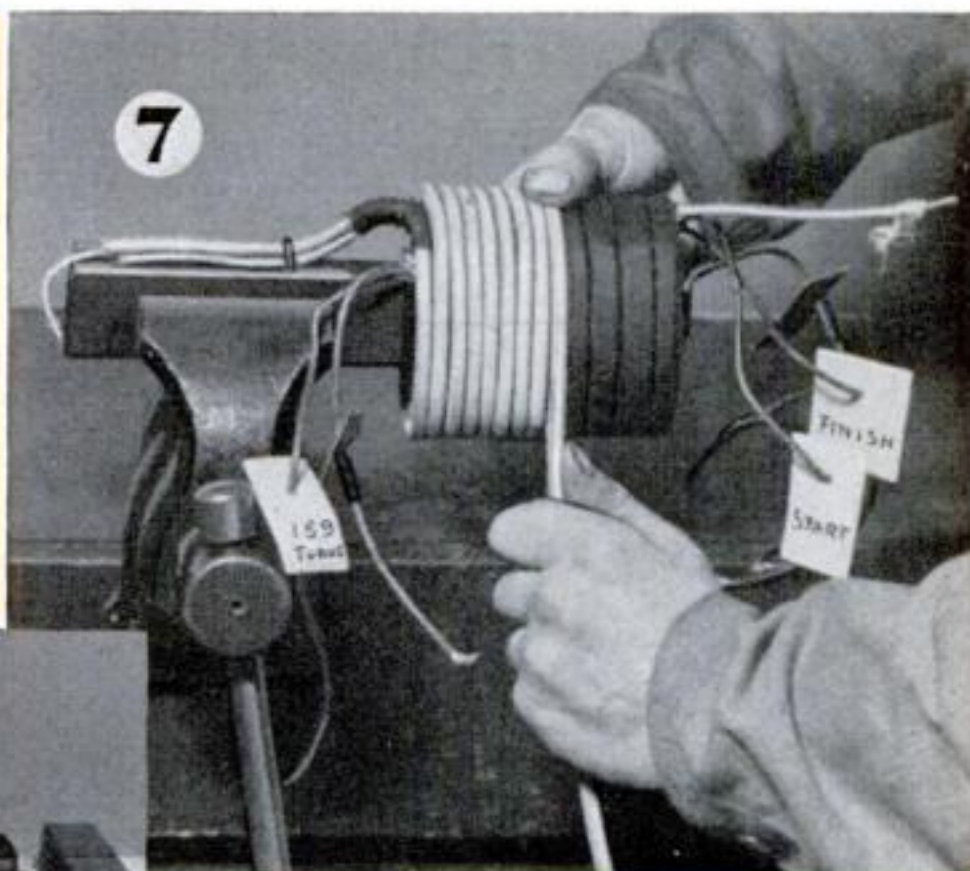
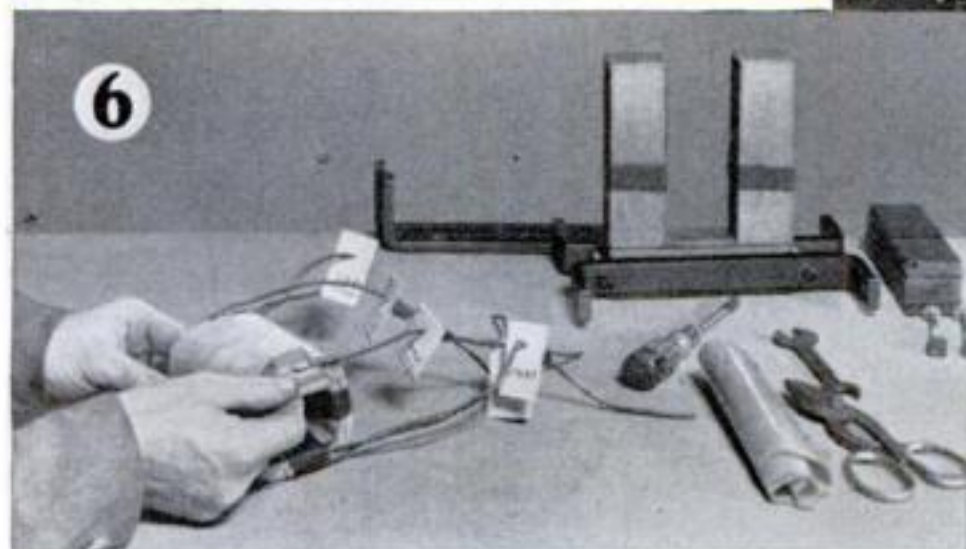
The primary is now prepared for the secondary winding by wrapping two layers of varnished cloth over it and following this with a layer of friction tape. The latter, because of its adhesive qualities, prevents the heavy wire of the secondary from skidding off as it is being wound.

The wire is put on as in Fig. 7 by the simple method of wedging the coil on a square wooden block and placing this in the vise. For the few turns required (16), the block can be shifted a quarter turn at a time in the vise while the heavy wire is laid in place. A band of friction tape is placed around the two wires near their ends, and an end of the tape allowed to go under the next turn following, as shown, so as to keep the end turns of the coil from slipping off. Insulation between the two layers needs to be only tape, or brown wrapping paper will answer, if preferred.

Next month Mr. Strand will tell how to complete the outfit and put it to practical use.

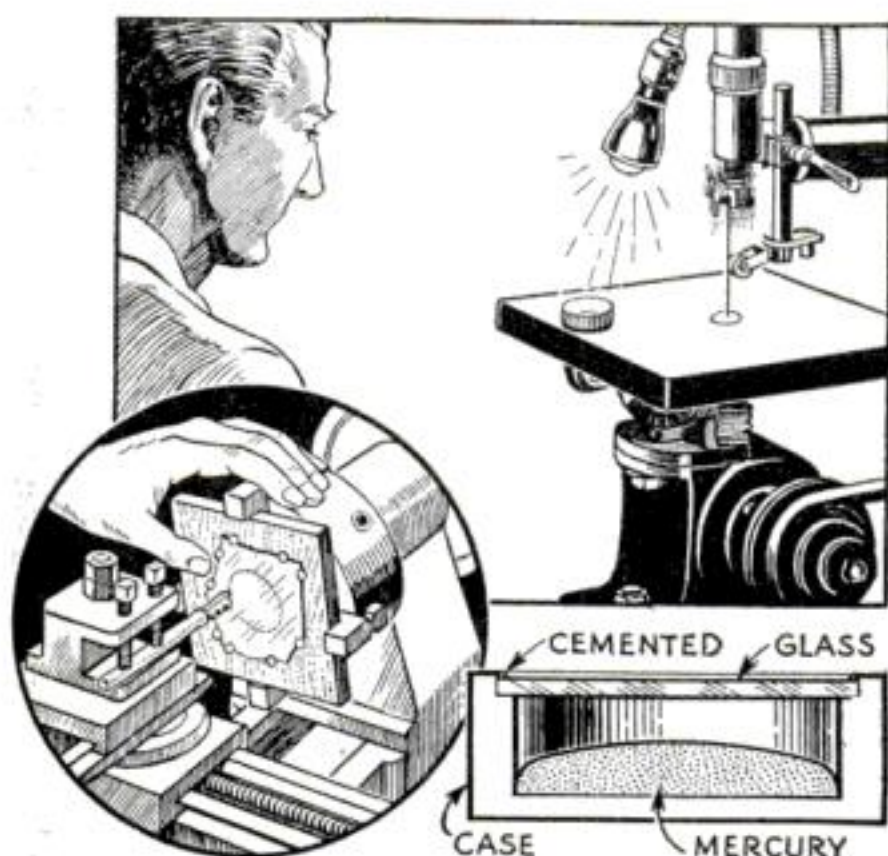
LIST OF MATERIALS

- About 3½ lb. No. 14 S. C. E. magnet wire
- 2 pc. about 19' long, flat magnet wire, 0.225" by 0.130"
- About 18 lb. sheet stovepipe iron
- 4—3" by ¼" roundhead stove bolts with washers
- 2—125-amp. and 3—90 amp. solder-type copper lugs
- 2—2" by ¾" roundhead brass machine screws; 2—¾" brass wing nuts; 4—¾" brass hexagon nuts; 4—¾" brass washers
- 4—1½" by ¼" roundhead stove bolts and washers
- 1 pc. ¾" plywood, 10" by 7"
- 1 pc. 3/16" hard fiber, 3½" by 3"
- 1 large radio panel knob with arrow
- 1 pc. brass rod, ¼" round by 2½" long
- 3—¼" brass nuts
- 1 pc. flat, hard brass, 2" by ½" by 1/16"
- 4—10-32 machine screws, roundhead brass, with heads filed flat
- 8—10-32 brass nuts
- 1 brass cabinet door handle
- 1 single-pole toggle switch and plate
- 1 cord grip connector with threaded end and lock nut
- 8' heavy-duty extension cord (No. 16) and 1 cord attachment cap to fit
- 1 cord connector
- 1 pc. ½" strap iron about 5" long
- 4 pc. 14½" by 1" by 5/16" soft steel
- 2 pc. No. 4 or 5 flexible motor lead wire, each 9' long
- 1 soldering-iron handle, large
- 1 pc. round brass rod, 11" long, ¾" diameter
- 1 solderless wire connector for about No. 2-0 wire
- 1 heavy battery clip
- 6—9-mm. solid carbons (giving 5 spare)
- Paint, small bolts, varnished cloth, tape, flexible lead wire, etc.



The secondary coil is wound over the primary, which is held on a square block. Two layers of sixteen turns each are used, and the ends later connected in parallel. Note tape holding wires near their ends

Mercury Detector Traces Source of Vibration



REPAIRMEN, mechanics, and photographers often run into difficulties caused by vibration that is not easy to trace. When, however, you know just where vibration exists, you have it half licked. The simple vibration detector illustrated above will enable you not only to locate it, but also to gauge roughly its intensity.

The detector consists of a pool of mercury in a glass-covered housing made from a large plastic jar cap. It was chucked in a lathe, and a recess bored out to receive a circular glass cover. The top of the cap, which was convex, was flattened on a belt sander. If you use a metal case instead of a plastic

one, give the inside several coats of lacquer to prevent the mercury from forming an amalgam with the metal.

The glass cover was cut by tacking a piece of scrap glass to a piece of wood held in the lathe chuck, and mounting the glass cutter on the tool post. The wheel of the cutter was brought against the glass, and the headstock spindle rotated by hand.

Obtain enough metallic mercury to form a pool on the bottom of the housing. If the mercury is not clean and bright, remove the scum by straining the mercury through cloth. With the mercury in place, apply some cellulose household cement around the recess, and press the glass cover into place.

To use the detector, set it on the machine, camera, enlarger, or other object and stand where light reflects from the mercury surface into your eyes. The mercury will be broken up into waves by vibration. You can gauge the intensity by the violence of the agitation, and note whether the intensity rises and falls in cycles.—W. E. B.

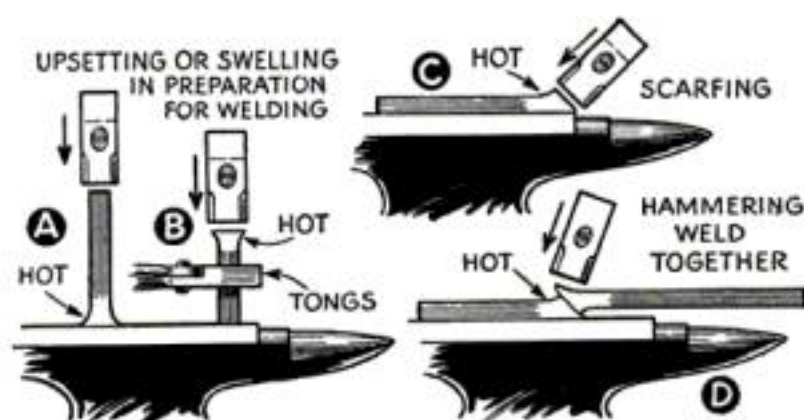
Tool Rack for Use Under Car

WHEN a new creeper was purchased for an auto-repair shop, a mechanic converted the old one into a useful under-car tool rack. He added a three-sided frame of 1" by 3" wood and a sheet-metal base, which was bolted to the slatted surface of the old creeper. It holds small tools and materials, and can be pulled alongside the creeper on which the mechanic lies.—W. C. W.

FORGE WELDING, PART 3

[METAL WORKING]

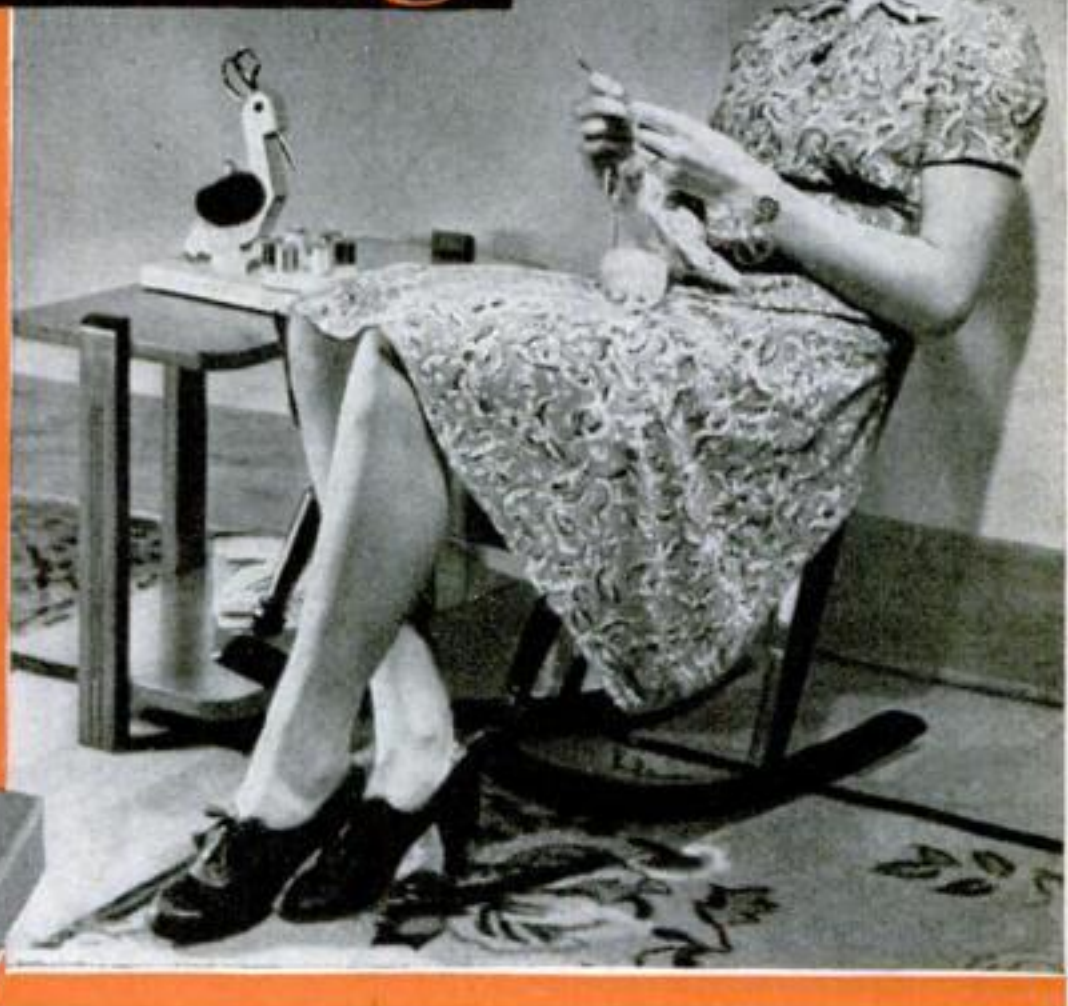
While forge welding can be accomplished without preparing the metal in advance, the weld is likely to be ungainly unless the pieces are scarfed (beveled) so that they will overlap. Furthermore, to compensate for any loss of metal due to melting in the fire, the pieces are generally upset or pushed back, thus making them thicker at the spot where they are to be welded. It is better to heat the pieces (short heats are easiest to work) and upset the ends as shown at A and B, then scarf them as at C.



They are brought to the welding heat, fitted together on the anvil, and hammered together as at D. A flux is not essential, but clean sand, borax, or a commercial flux may be used, if desired. The completed weld should be somewhat thicker at the joint because it is a relatively simple matter to draw the metal out, but almost impossible to thicken the metal at a welded joint if it is too thin.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

WORKING TIME: One Evening



Novel Sewing Kit Represents Duck and Nest

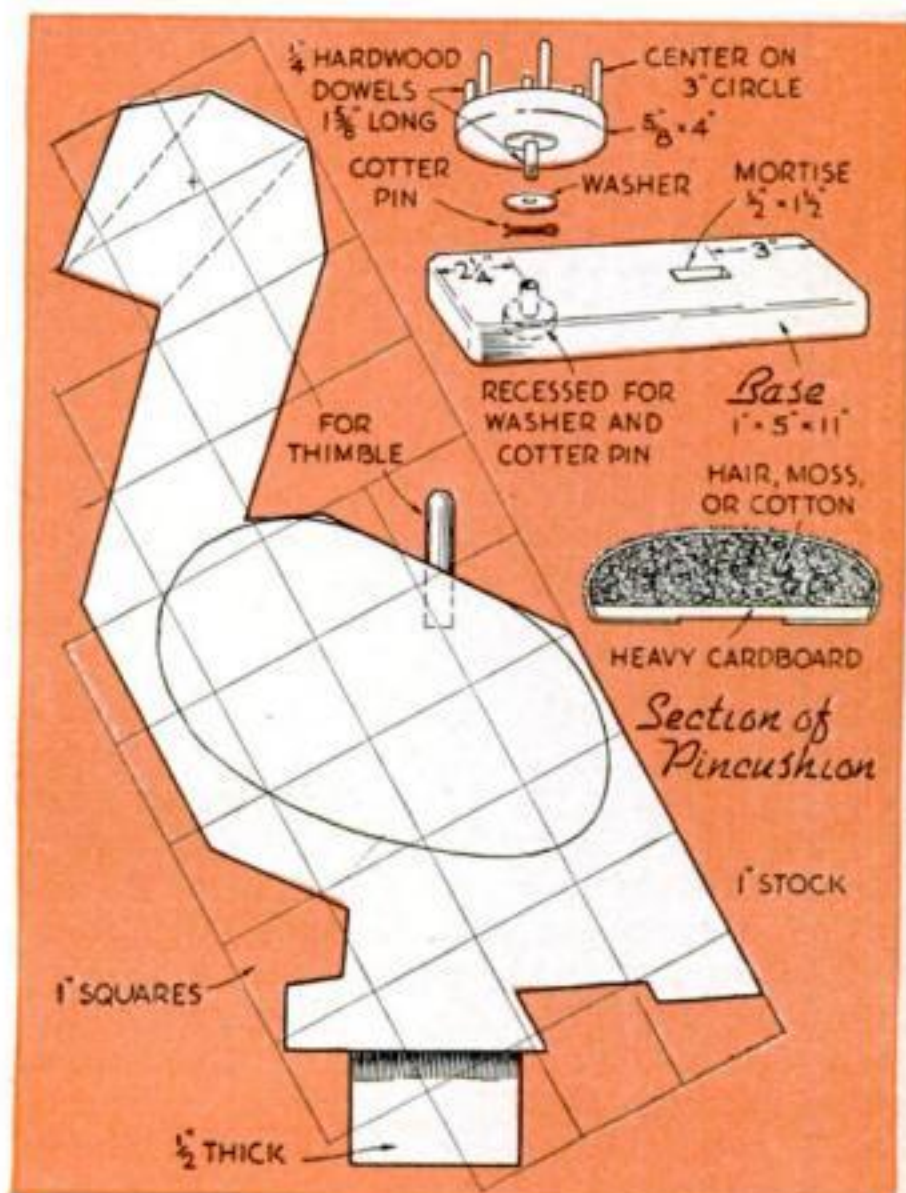
CRAFTSMAN'S TIME.....2 hours
BEGINNER'S TIME.....3 hours

IN THIS variation of the so-called "bird sewing kit," a jaunty modernistic duck guards a nest of spools. The duck has pin-cushions for wings and scissors for topknot and beak.

Cut the duck from stock a full 1" thick, and reduce the tenon thickness to $\frac{1}{2}$ ". The base, which is a rectangular piece with chamfered corners, is mortised through to receive the tenon.

Make a spool turntable of $\frac{5}{8}$ " stock, 4" in diameter. The hardwood dowels to hold the spools are centered on a 3" circle. The disk revolves on a dowel passing through a hole in the base, where it is prevented from being withdrawn by a washer and cotter pin fitting into a counterbored recess under the base. Insert a washer between disk and base.

Finish the piece in white enamel or decorate with bright colors. Make two wing pads by shaping velvet or velour over suitable padding material backed with a heavy cardboard form. Hold the edges with thread, and glue the flat backs to duck.—E. L.





Made of walnut and glass, this tray presents a striking appearance and is always much admired

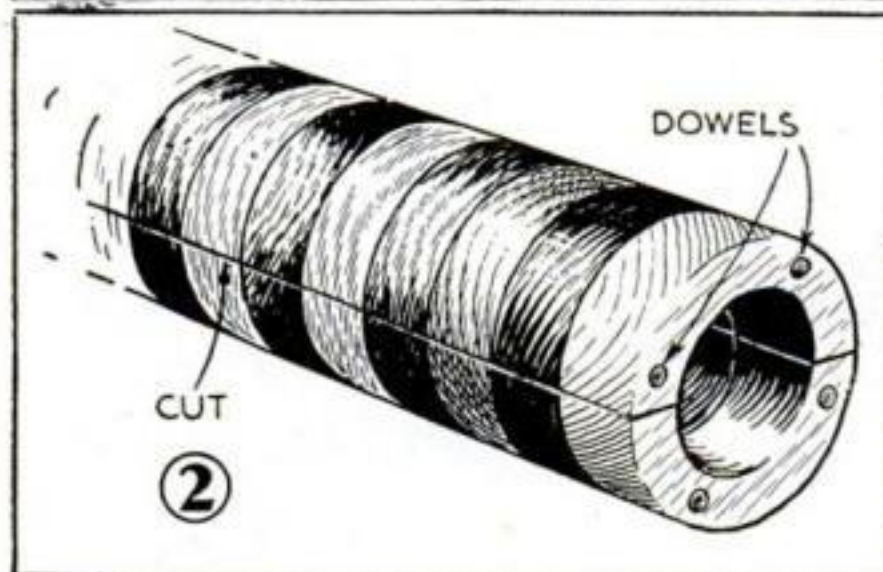
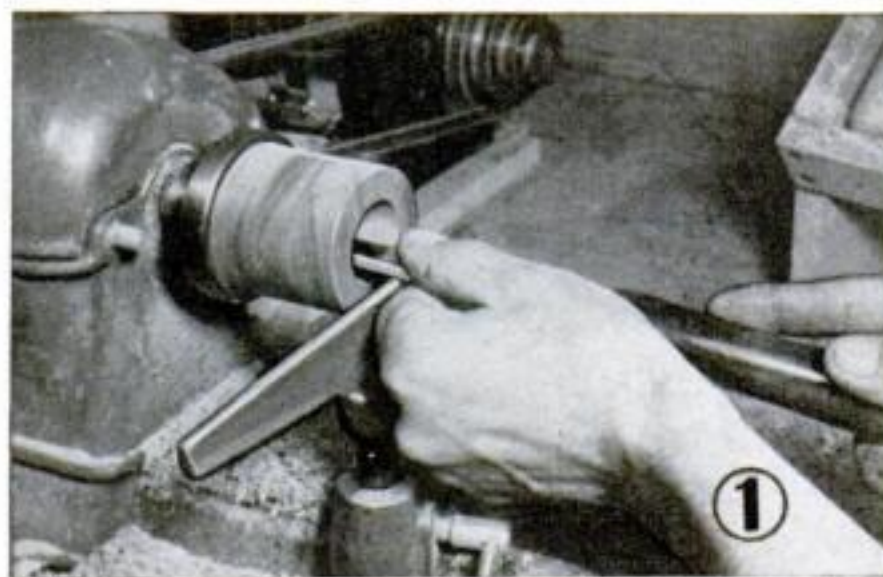
VARI-COLORED threads decorate the transparent glass bottom of this unique, modern-looking tray.

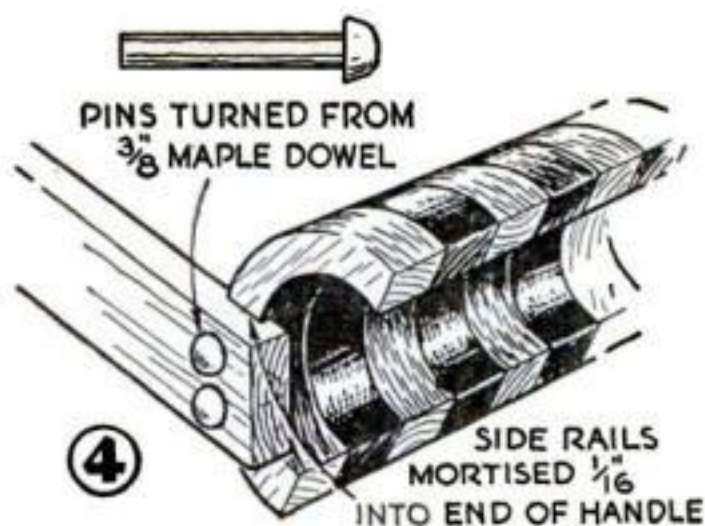
For handles, select $\frac{3}{4}$ " thick walnut scraps of varying shades and interesting grain, and cut nine disks $2\frac{1}{2}$ " in diameter. Glue the disks together in sets of three for ease in turning out the centers. Then mount each unit on the faceplate of the lathe (Fig. 1) and bore out to $1\frac{1}{2}$ ". Dowel all nine units together as in Fig. 2, and make a mark across an end disk to indicate where the cylinder is to be sawed to avoid cutting through the dowels. Sand the inside of the cylinder with a small sanding drum as in Fig. 3. Finally, cut the cylinder in two sections, each half to become a handle and end of the tray.

For the side rails cut strips $\frac{1}{2}$ " thick, $1\frac{1}{8}$ " wide, and $18\frac{1}{8}$ " long. Then, $\frac{3}{16}$ " up from the lower edge, cut a groove $\frac{3}{16}$ " deep and wide enough to take the double glass bottom. Drill two $\frac{1}{4}$ " holes in each end to receive the headed maple pins, which are turned from $\frac{3}{8}$ " maple dowels (Fig. 4).

UNIQUE MODERN Cocktail Tray

WITH TRANSPARENT GLASS BOTTOM

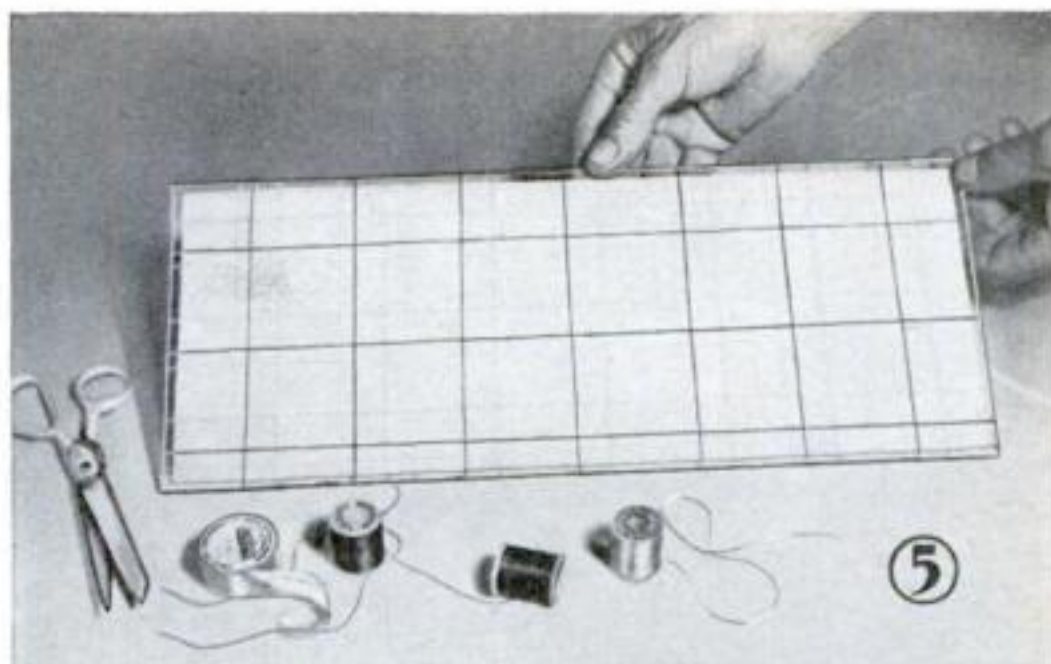




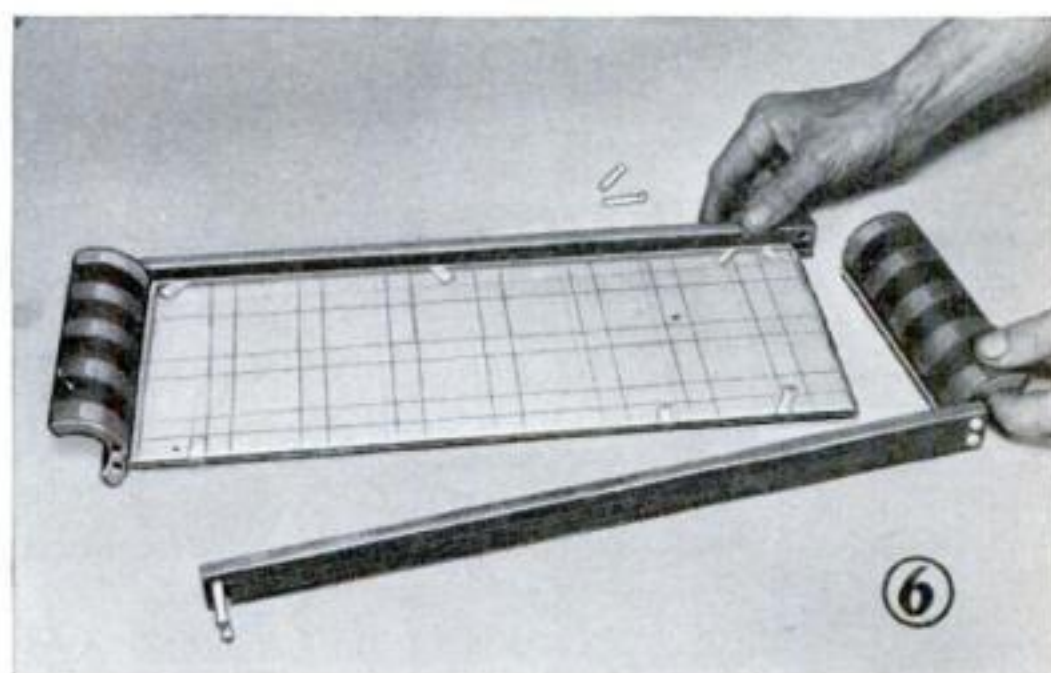
Beginning $\frac{7}{8}$ " up from the lower edge of each handle, make a similar groove $\frac{3}{16}$ " deep, as shown. The side rails are then fitted into $\frac{1}{16}$ " deep dados cut into the ends of the handles.

For the bottom of the tray, obtain two pieces of double-strength glass 7" by 17". Have the sharp corners ground off. Cut a piece of heavy paper $6\frac{1}{2}$ " by $16\frac{1}{2}$ ", place under one piece of glass, and wrap silk threads in the desired colors completely around the glass and paper so as to form the design on the glass side as shown in Fig. 5. Use cellulose tape to hold the threads in position at the edges. The threads run diagonally on the paper side, but that does not matter, because they will be cut off later.

Place the second piece of glass on top of the design and tape the assembly together at the edges to hold until inserted in the frame (Fig. 6). Litharge powder (obtainable at most large drug stores) mixed with glycerin to the consistency of a thick paste is used in cementing the glass bottom in the grooves, making liquidproof

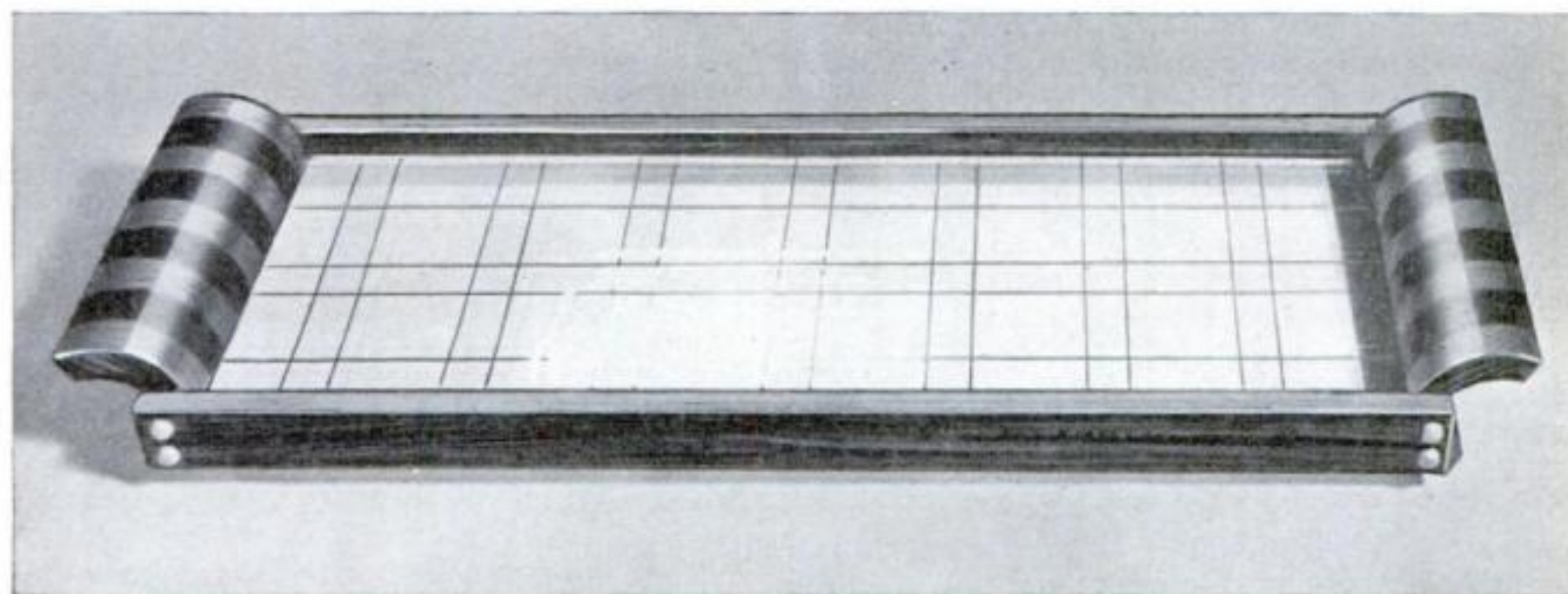


Bright silk threads are wrapped around the glass and heavy paper, and held temporarily in place with cellulose tape



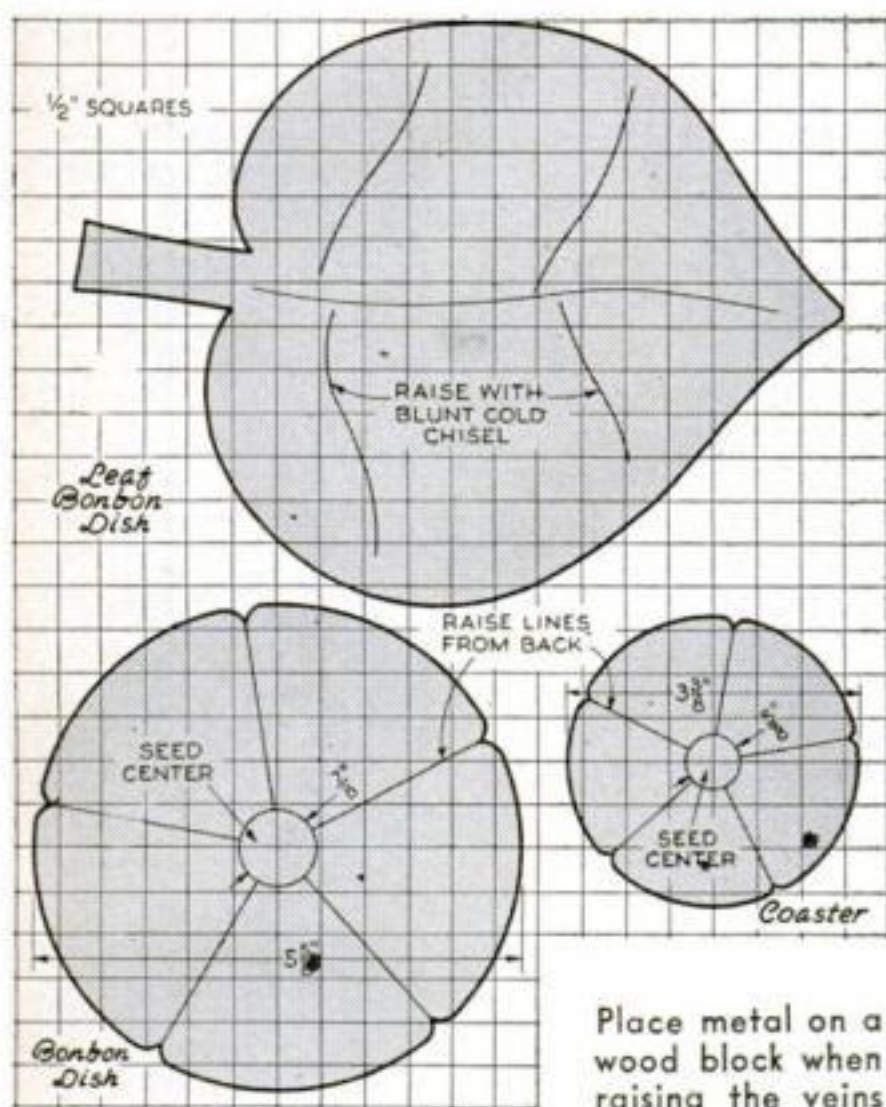
Assembling the tray. Litharge powder mixed with glycerin is used to cement the double glass bottom in the grooves

joints. After the tray is assembled, the diagonal threads are cut away and the paper removed, leaving the remaining threads between the pieces of glass. For finishing the handles and side rails, use only the best grade of spar varnish obtainable.—BENJAMIN NIELSON.



The thread design in the glass adds a novel touch to the tray. Contrasting woods form the handles

Metal Bonbon Trays Shaped Like Flowers and Leaves




**CLOCKED
PROJECT**
Average Time
5 1/2 hours

mered on the face. Sketch the veins in on the back and, after placing the metal on a wood block, hammered side down, raise the veins lightly with a blunt cold chisel. Round the stem a little with the ball end of a ball-peen hammer. Raise the edge of the leaf about $\frac{1}{2}$ ", and bend the stem to form a finger handle.

The water-lily bonbon dish is of 18-gauge nickel silver. It is hammered, and the veins are raised from the back. The center is done with a paneling punch, or with a hollow-end nail set and a center punch. The rim is raised about $\frac{1}{2}$ ".

The four coasters are of 18-gauge aluminum and similar to the water-lily bonbon dish. All the pieces should be polished.

DISHES and trays of leaf and flower design may be made from aluminum, nickel silver, or stainless steel. The leaf-shaped bonbon dish shown is cut from 18-gauge soft sheet aluminum, and is ham-

Mantel Clock Transformed into Wall Clock with Painted Case of Dutch Design

IF YOU have a small, inexpensive electric mantel clock and no shelf room to hold it, a good way to make use of it is to convert it into a Dutch wall clock. Cut out a new wooden front as shown and insert the face and works of the electric clock. The front piece is painted with either flat oil colors or enamels. If enamels are used, rub the surface down, when thoroughly dry, with pumice stone and oil to give an artistic semigloss finish. The clock front illustrated at the right is 7" wide and 10" high and was cut from plywood.—HENRY R. DIAMOND.





Decalcomania designs are used for decorating the sheet-cork facing. The uncovered part of the sheet-iron backing is painted with a bright enamel. The rack is shown in use at the left

Decorated Cork Covers Face of Breakfast-Newspaper Holder

READING the morning newspaper while eating your breakfast becomes a greater pleasure when the paper is propped against this novel rack, which was designed by a member of the Metropolitan Junior Achievement, New York. A strip of sheet iron, 8" wide by 24" long, is the supporting material. On this a sheet of 1/16" sheet cork is glued. After the glue has dried, the cork-faced strip is bent as shown, the highest "peak"

being about 7" tall. Paint the uncovered iron with bright enamel and apply decalcomania (transfer) designs to the cork.

Wanted . . . Three-Hour Craftwork Projects

Have you built any original craftwork novelties that take only an evening to finish? If so, send us brief, well-illustrated articles describing them. Cash is paid upon acceptance for all available material.

SOLUTIONS

[METAL ETCHING—1]

Etching solutions should always be mixed in glass containers. Glass photographic trays are excellent for flat work. Heavy, square fish bowls are best for large work. Earthenware is not satisfactory as the material, unless very heavily glazed, will absorb the solution.

Nitric acid is used in etching most metals. In many cases, one part commercial nitric acid is added (CAUTION: Do this very slowly and carefully) to one part of water. Full-strength acid may, however, be used with satisfactory results and much greater speed. Where the process of etching is carried out with a slow etching solution, it is well to stir occasionally, or rock the tray from time to time to remove any bubbles and the scale that forms and interferes with even biting.

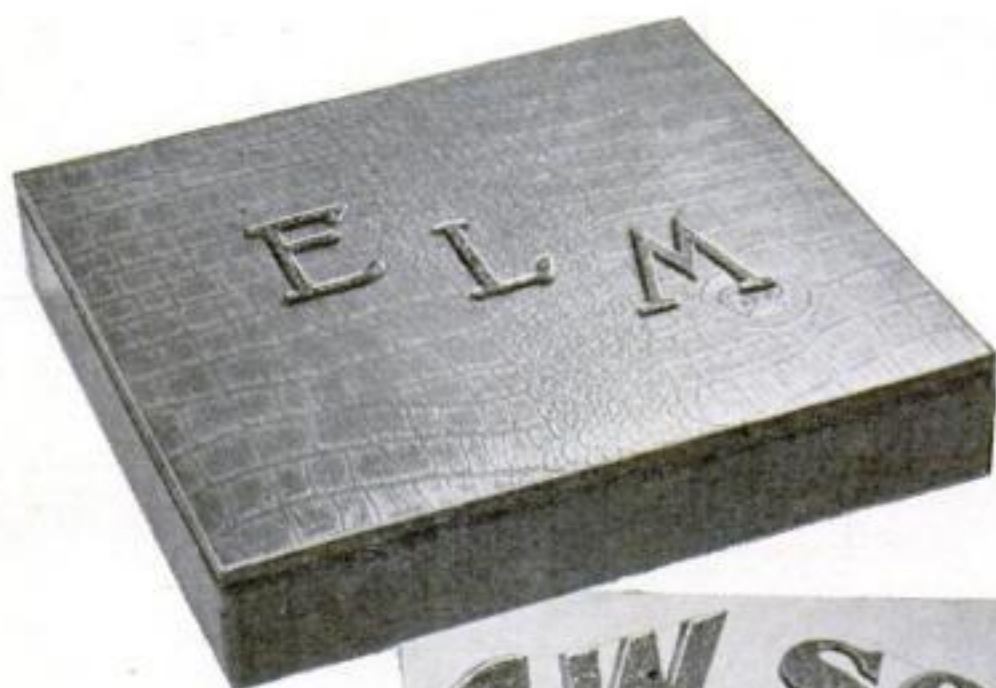
Store all etching solutions and clear acids in glass-stoppered bottles. To relieve burns received from acids, apply sweet milk. Olive oil is next best. If nothing else is available, apply plenty of water.

If, in etching copper or brass, it is desired to leave the undercuts dark to set off the work in a polished piece, coat the etched parts with a solution of liver of sulphur (potassium sulphide). Wash this off before removing the asphaltum. To make the solution, dissolve a piece of liver of sulphur the size of a thimble in about a pint of water.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

Decorative Leather Initials

CUT OUT IN QUANTITIES ON A SCROLL SAW



A large number of initials may be cut at one time on the scroll saw, as shown at the left. Use a very fine saw blade



Large initials may be hand-tooled to match any leather article to which they are to be applied

WHETHER or not you have ever attempted leather craftwork, you will find the making of leather initials and monograms is a practical hobby. Under favorable circumstances it might also be developed into a profitable one.

Identifying initials are desirable on so many different articles, in addition to those made of leather, that the list is endless. Thin metal initials, however, bend out of shape readily or become dented, those of thin plastic break easily, and transfer initials wear off all too quickly. Leather initials do not have any of these objections, and you can apply them, either plain or hand tooled, to any type of surface with cellulose household cement.

Scraps and small pieces left over from leather-work projects are entirely suitable. While the cutting may be done by hand, the secret of rapid production is to use a scroll saw. Cut the pieces into uniform squares, using a print trimmer if one is available. Stack the squares into blocks up to 1" thick, fastening them together with rubber cement. To the top, cement a tracing of the initials or monograms. Suitable letters can often be clipped from magazines and newspapers, and these may be cemented to the blocks without taking the trouble to make a tracing.

If a power scroll saw is used, the blade should be a very fine one. The writer uses thin, narrow blades intended for cutting

jig-saw puzzles. When the cutting has been done, separate the individual initials and rub off the rubber cement from both sides.

For most purposes the initials are used plain, but they can be dampened and hand-tooled with border lines or embossed designs if it is desired to match the leather article to which they are to be attached. Special leather modeling tools are not required because a nail set, punch, or awl can be ground or rubbed on an oilstone to a smooth, blunt point that will give the kind of line required.

Aside from tooling the initials, they can be given a number of attractive finishes by other means. A bronze appearance is ob-

tained by painting the leather with a solution of one part methyl violet in eight parts of water, the measurement being made by weight. To give the effect of white veining, rub in a little paste white lead—that is, white lead ground in oil—and then remove the excess and allow it to dry.

For a patent-leather finish, mix 1 oz. of asphalt varnish with 5 oz. raw linseed oil, and add 2 oz. of copal varnish. Up to 5 oz. of turpentine may be mixed in to thin the material to a flowing consistency.

With or without a special finish, the initials are attractive on hand bags, gloves, cameras and camera cases, luggage, and many other articles.—KENNETH MURRAY.

Toast and Bread Tray of Brilliant Plastics

SPARKLING color contrasts and ease of working make modern plastic materials extremely desirable for home workshop use, as in the case of this small toast and bread tray. It is built up of $\frac{1}{8}$ " black and $\frac{3}{16}$ " yellow plastic.

The sides are 3" by $7\frac{3}{8}$ ". Carefully miter the long lower edge of each by planing the material against mitered guide blocks. The planed edges are roughened with coarse

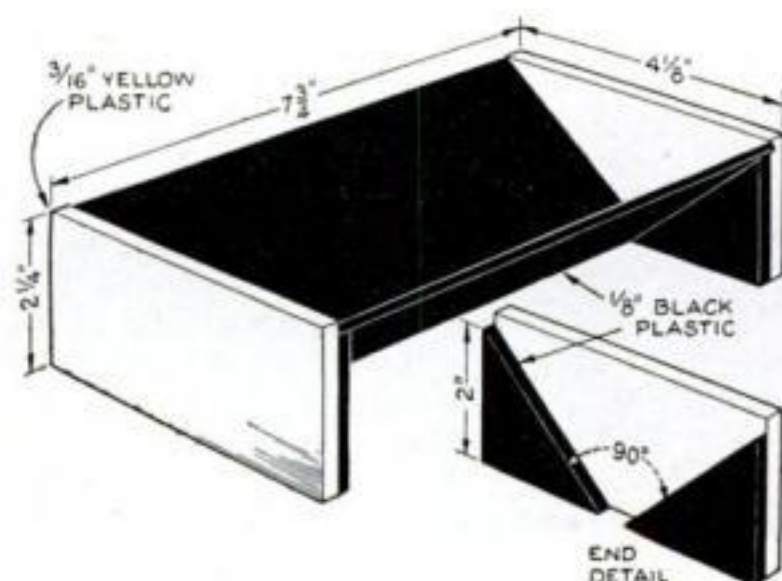
sandpaper and joined in a clamping jig with the special transparent cement sold for fastening the plastic material. The ends of the tray are made of three pieces each—one yellow end rectangle to which is cemented two black 45-deg. triangles. All excess cement must be scraped lightly from the joints before it has set.

The completed tray may be buffed with an unsewed wheel and some plastic buffing compound, or a highly

satisfactory sheen will result merely from rubbing the material with very fine steel wool.—TOM E. MOORE.




CLOCKED
PROJECT
—
Average Time
4 hours



What Model Makers Should Know About **BALSA WOOD**



Balsa wood. The surface at the left is known as an "A" cut. It has a velvety look and feel. At the right is a speckled "C" cut

By **FRANK ZAIC**



Above, method of testing balsa wood and basswood. Both woods have approximately the same weight but the basswood bends twice as much. At right, all-balsa model using "C" cut for all parts except the prop

IN ECUADOR there are trees that mushroom up to heights of from forty to sixty feet in a comparatively short time. It is not unusual for them to attain diameters of from 12" to 18" within five years. If you were to follow one of these trees through the many processes that lie between the living tree and usable wood, you would eventually find it on the workbench of a model-airplane builder. This, in a nutshell, is the life story of the world's lightest wood, balsa.

The weight of balsa has been standardized at 8 lb. per cubic foot, but it varies in practice from 4 to as high as 20 lb. The rate of growth and the resulting weight depend on the local conditions. The growth is greatest in open spaces, near water and where the



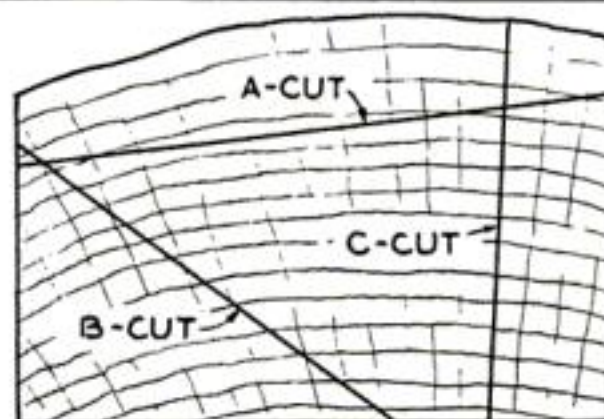
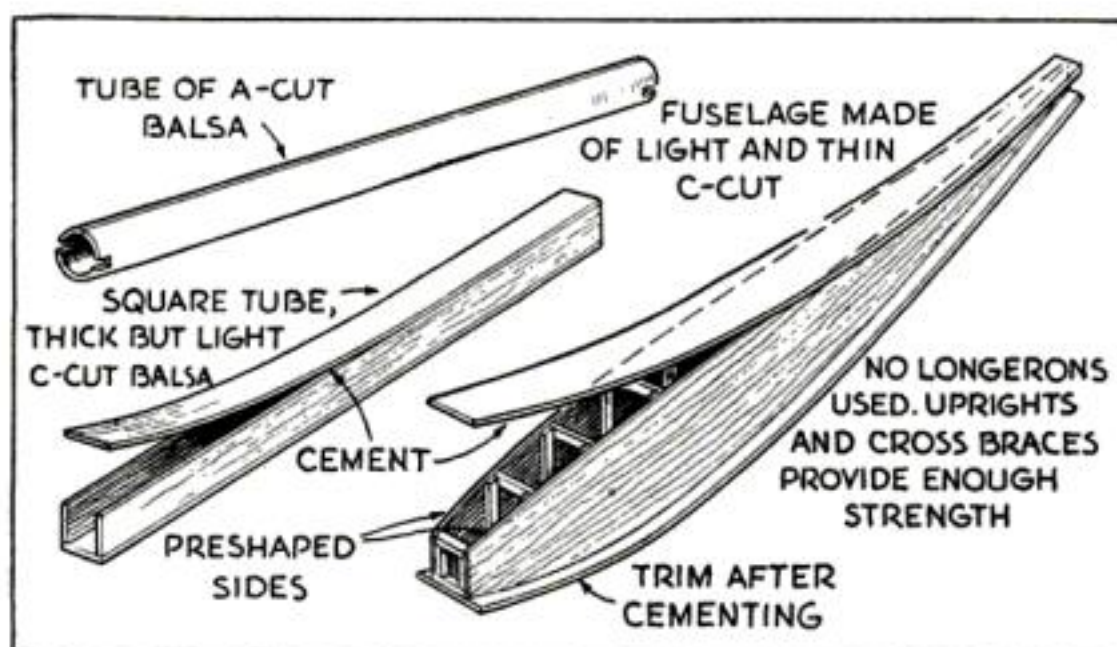
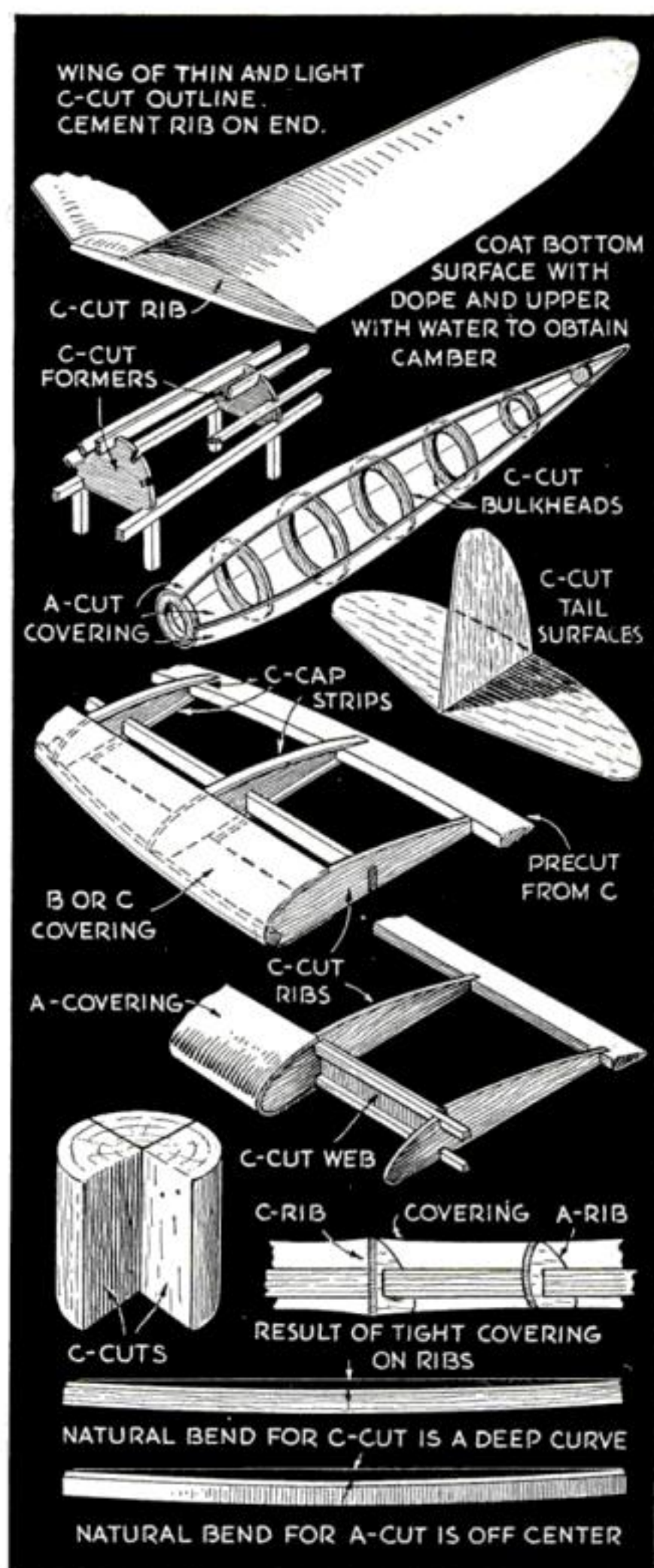
soil is moist. The lightness and softness of balsa is due to its large, thin-walled cells. It is easily compressed with a finger nail, and nails or screws cannot obtain a secure hold. It takes glues or cements exceptionally well because its large, open cells allow the adhesives to flow into them and thus insure good anchorage.

Although balsa is used for many commercial purposes, such as floats and insulation boards, the bulk of the output is employed for model airplanes. It is estimated that American boys use about 3,500,000 board feet of balsa every year. (A board foot is 1" by 12" by 12".)

The advantage of balsa over hardwood for model airplanes lies in the ease with which it can be shaped with a sharp knife or a razor and also the fact that it can be used in comparatively large sizes. It is well known that deep spars produce rigid construction. For example, a 1" by 2" spar, when equally loaded while it is laid flat and on edge, will bend twice as much in the flat position. Also, if the size is increased to 1" by 4" and a similar load placed on its edge, it will bend only one quarter as much as the 1" by 2" did while also on edge.

Since balsa is so much lighter than hardwood, we can use large spars to produce rigid construction with lightness—a most desirable condition for model planes, which have to maintain their aerodynamical settings for flying and stability.

You can easily test the comparative bending qualities of balsa and hardwood. Cut a $\frac{1}{4}$ " by $\frac{1}{2}$ " by 12" strip from 8-lb. balsa, and a $\frac{1}{8}$ " by $\frac{1}{4}$ " by 12" strip from basswood. Both pieces will weigh approximately the same since basswood weighs about 30 lb. per cubic foot. Cement the ends on a board and suspend equal weights from the free ends. You will find the basswood bends about twice as much as balsa, just because it has less cross-sectional area for similar weight. It is, of course, understood that both strips would very likely break at similar maximum loads, since the strength



Above, how the three cuts are obtained from a balsa log. At top and at left, methods of using balsa in model-airplane construction

of a material is more or less determined by its specific gravity. Balsa can be used highly loaded without having it bend excessively, or we can say that balsa is much more brittle than ordinary hardwood.

The natural grain characteristics of balsa are similar to those of hardwood. Balsa sheets cut along the three lines shown in the drawing of a portion of a log have the same characteristics as those cut from hardwood. A sheet cut along the line marked "A" has a velvety look and feel. It will be found to bend very easily into tubular form. A piece cut like "B" has tiny speckles and feels stiffer when an attempt is made to bend it into tubes. "C" has large speckles and a glazed surface, and it is especially brittle against tubular bending. These special characteristics can be used advantageously for model work.

The so-called "C" cut is perfect for compression members such as ribs and bulkheads, also for all-balsa models. It can be loaded three times as much as an "A" cut of similar size before it will bend or buckle. But when it does buckle, it will do so without a warning and will snap cleanly into two. "C" ribs will keep shape under covering pressure that would normally double up the "A" type.

Bulkheads can be made from single "C" sheets instead of double-ply. Use the "C" cut whenever possible to obtain maximum strength with minimum of weight. The "C" cut will bend to some degree, the exact

radius depending on its weight and thickness. Light, thin, and moist "C" sheets can be made into tubes, but only after you have had some experience. One of the main rules is to keep the wood under constant tension as you roll it around the bending rod.

The "A" cut is a natural bender and can be bent considerably without moistening. When moist, it will bend into surprisingly small diameters. Use it for tubes and for covering sharp curves.

"B" cuts have the in-between characteristics of "A" and "C". They should be used when bending requirements exceed the "C" specifications, but are not so severe as those which only "A" can handle.

So far we have covered the grain uses pertaining to sheet stock. Although "C" cut is best for deep spars because it will resist twisting forces, it was found that such spars will have a natural tendency to curve, so that it is difficult to make surfaces flat. Since it is more important to have a perfect aerodynamical line-up than a slightly stronger construction, we have to be satisfied with spars cut from "A" stock. The natural bend on "A" spars is in a direction easily counteracted during construction. Use "C" stock, by all means, when the outline, such as trailing edge, is of curved variety and cut from sheet. Just consider in each case which you would rather have—a good anti-twisting but possibly bent spar, or the straight "A" type.

(TO BE CONCLUDED)



Above, an example of multiple stringer construction. Note the smooth lines of the plane. At the left, the Good brothers with their balsa model controlled by radio, which has been a consistent winner at model-airplane meets during the past three years



Track

Rails should be cleaned frequently by wiping them with a rag moistened with carbon tetrachloride or similar cleaner

Maintenance

ON YOUR MODEL RAILWAY

KEEPING track in good condition is every bit as important on a "tin plate" model-railway layout as on a real system. Eventually, neglect results in short circuits and in the general slowing down of the trains and unsatisfactory operation of the system.

Before assembling a layout, pinch the openings in the rails in which the pins of adjoining sections fit. Use a pair of long-nose pliers placed between the opening and the bottom of the rail as illustrated. In addition, rub down the tops of the rails and pins with a very fine grade of steel wool. Make sure the track connectors hold the sections tightly together.

Check the insulation of the middle rails by connecting two wires to a dry cell, or to the transformer. Hold one end on the outside rail and touch the other to the

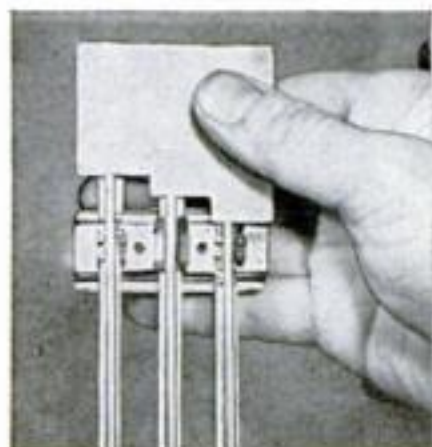
middle rail. If a spark results, replace the insulation material under this rail at the three points where the rail is clipped to the ties.

The most efficient way to introduce current into the system is to solder wires to the underside of the rails. This prevents loss of voltage due to poor connections, and on any but the smallest layout this should be done about every five sections. Use red-covered insulated wires on the middle rails and black-covered insulated wires on the outside rails. The colors make identification easy.

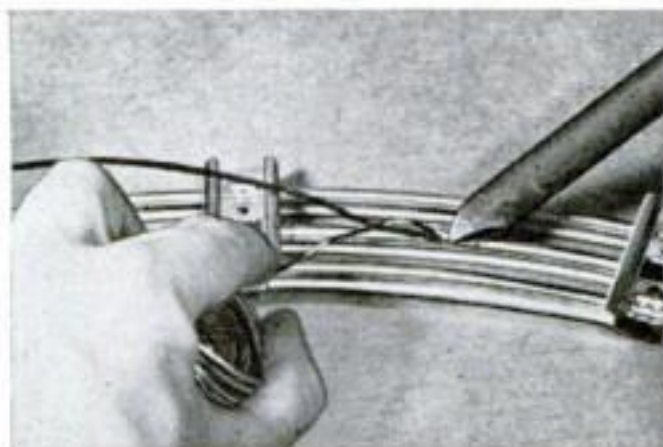
On curves, place short lengths of match sticks under the outer edges of the ties to give sufficient elevation to

allow the train speed to be increased without the danger of derailments. For an extremely smooth riding surface, the ends of the rails may be staggered so the wheels do not bump over the joints in the track at one time. This takes time but is worth the trouble. Do not disturb the middle rails, which are insulated, but loosen the clips holding the outside rails to the ties and slide one rail forward and the other back $\frac{1}{4}$ " either way from the end of the middle rail. Then retighten the clips. At points where switches or crossings join, saw off the ends of the track sections square, as it is not practicable to alter the switches or crossings.

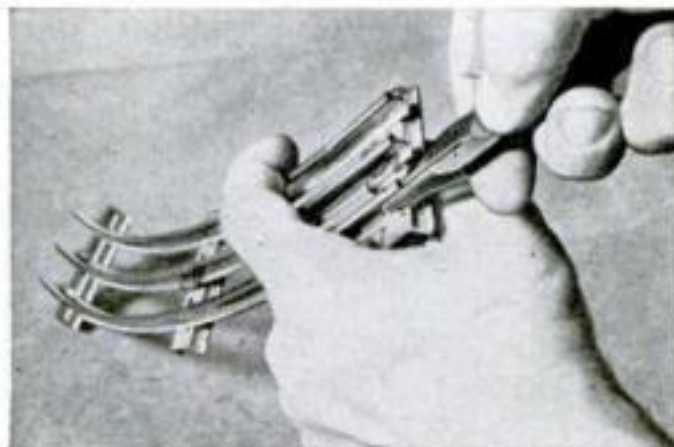
After the system is in operation, clean the rails frequently with a rag moistened with carbon tetrachloride or other safe cleaning fluid.



Using a gauge with $\frac{1}{4}$ " steps to stagger the rails so the wheels do not bump over all the joints at once. Center, soldering feed wires to the un-



derside of the rails. Above, pinching openings in the rails. This creates tighter joints when pins of adjoining sections are pushed into place



FIVE STUNTS WITH



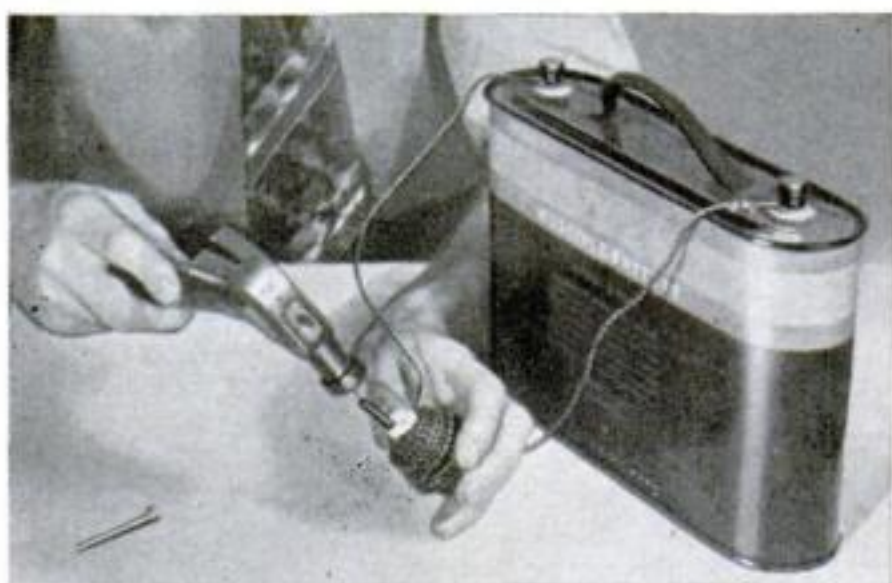
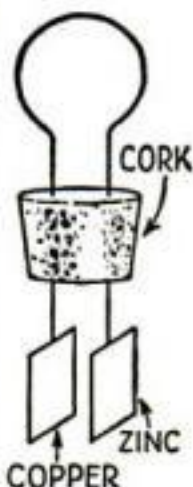
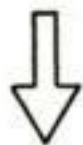
Simple Meter Is Made of Coil and Compass

WIND a dozen turns of insulated wire around a cardboard ring, insert a small compass, and you have a handy meter for volts or amperes. A pencil sharpened at both ends and inserted in series with the circuit, as shown at bottom of opposite page, will form a resistance of graphite to raise the voltage range. To increase the range for amperes, instead, a parallel connection or shunt by-passes the meter. At left it is demonstrating the surprising fact that the size of a wet or dry cell has nothing to do with its voltage, as shown by the compass needle's deflection. However, big cells give higher amperage, and last longer.



Tiny Homemade Cell Shows How Electric Motors Work

MAKE a loop of copper wire, about two inches in diameter. Pass the ends through a large, flat cork and solder them to small squares of zinc and copper, respectively. When this tiny electric cell is floated in a tumblerful of dilute sulphuric acid, current flows through the loop and sets up a weak magnetic field. Bring an electromagnet near, and the coil will align itself and slip over it. Reverse the battery connections of the electromagnet and the loop backs off, turns around to present its opposite face, and slips on again. Electric motors apply the same principle.



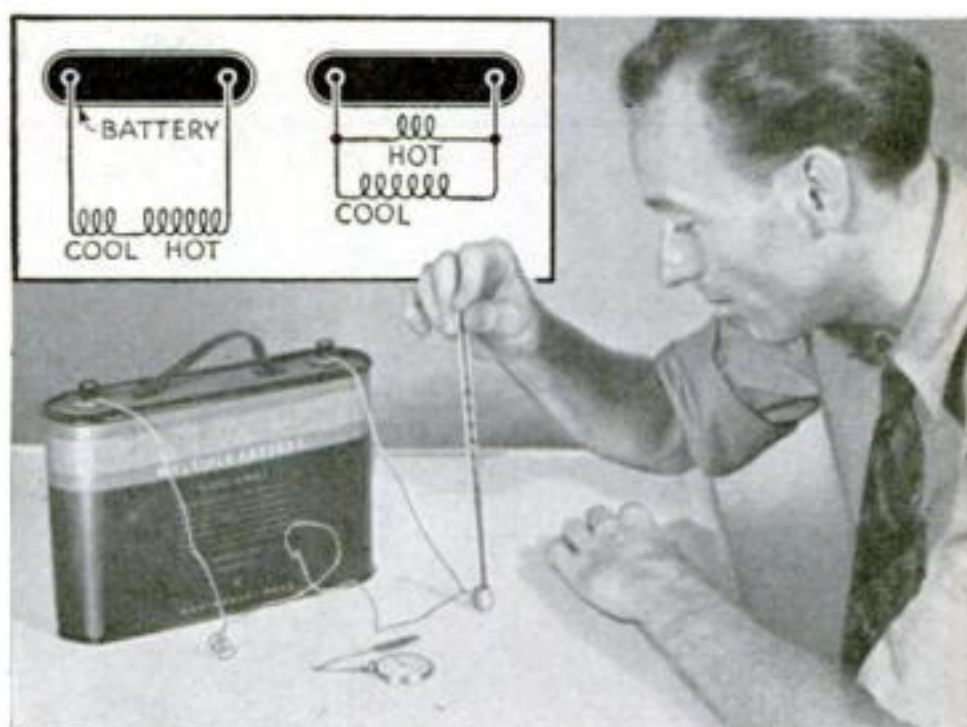
It's Easy To Magnetize Small Pieces of Steel

SCREW DRIVERS, scissors, and compass needles are easy to magnetize permanently. Wrap fifty turns of bell wire around a cardboard tube of about half-inch diameter. Connect this improvised solenoid, or coreless magnet, to several dry cells. To magnetize an object, simply insert it in the tube for a few seconds while the current is on, meanwhile tapping it with a hammer. This helps the molecules of steel to disentangle themselves and line up in one direction, giving the object its magnetism. Soft iron cannot be used for permanent magnets.

ELECTRIC CURRENTS

Changing Circuit Gives Different Heat Effect

TO SEVERAL dry cells, connect in series two coils of fine insulated wire, one of fifty turns and the other of 100 turns. Place a chemical-type thermometer within each coil and read its temperature after current has been flowing exactly one minute. The 100-turn coil becomes the hotter. Rearrange the coils in parallel, repeat the tests, and you will find that with this circuit the 100-turn coil is the cooler one!

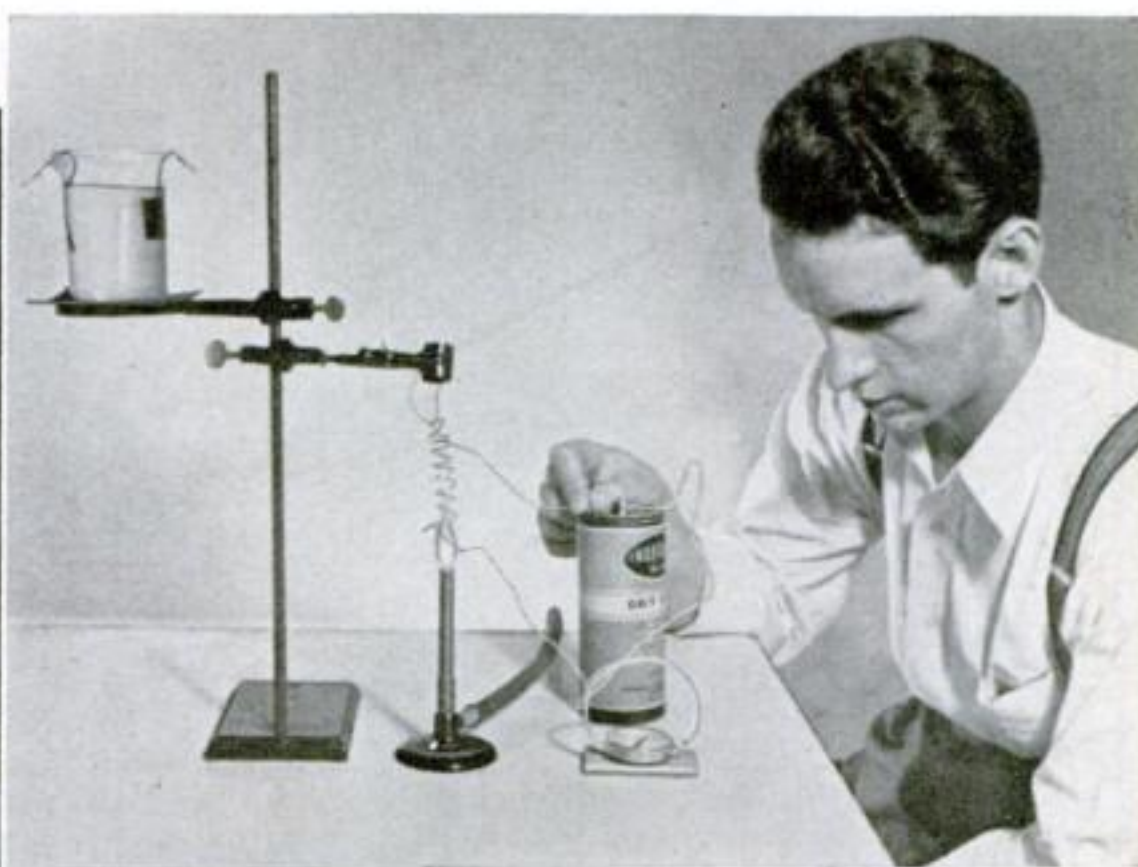


How Temperature Affects Resistance of a Conductor

CONNECT your homemade electric meter, in series, with a small coil of bare wire and a dry cell. Heat the bare-wire coil, and the current will decrease, as shown by the lessening deflection of the compass needle. The resistance of the wire has been increased by heating, so that less current is allowed through. Now substitute a beaker of cold, salt water for the coil, and connect the wires to metal plates dipping in the liquid. In this case, heating the



salt water will indicate a greater flow of current on your meter, owing to lessened resistance of the conducting solution. This illustrates a general rule of electricity—that heating a solid conductor usually increases its resistance, while heating a liquid conductor, or electrolyte, usually diminishes its resistance. No pencil resistance is needed, as this is an amperage test.



Heating the coil of wire increases its electrical resistance. At the left, a pencil "lead" included in the circuit of the homemade meter gives it wider range when used for testing voltages

HOMEMADE "Audio" Telegraph

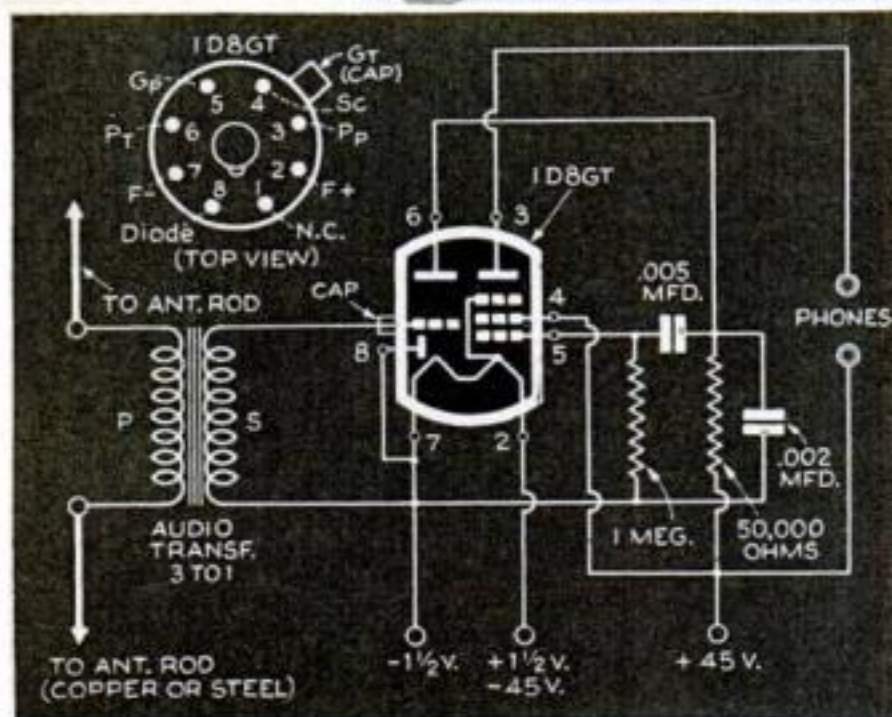
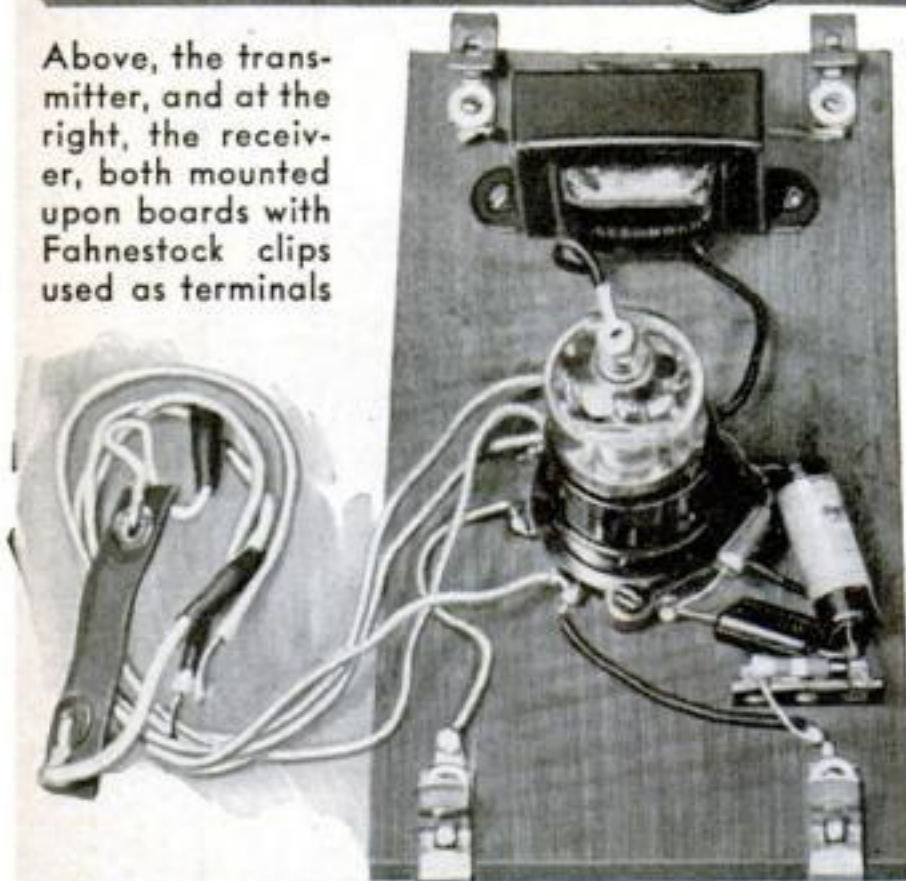
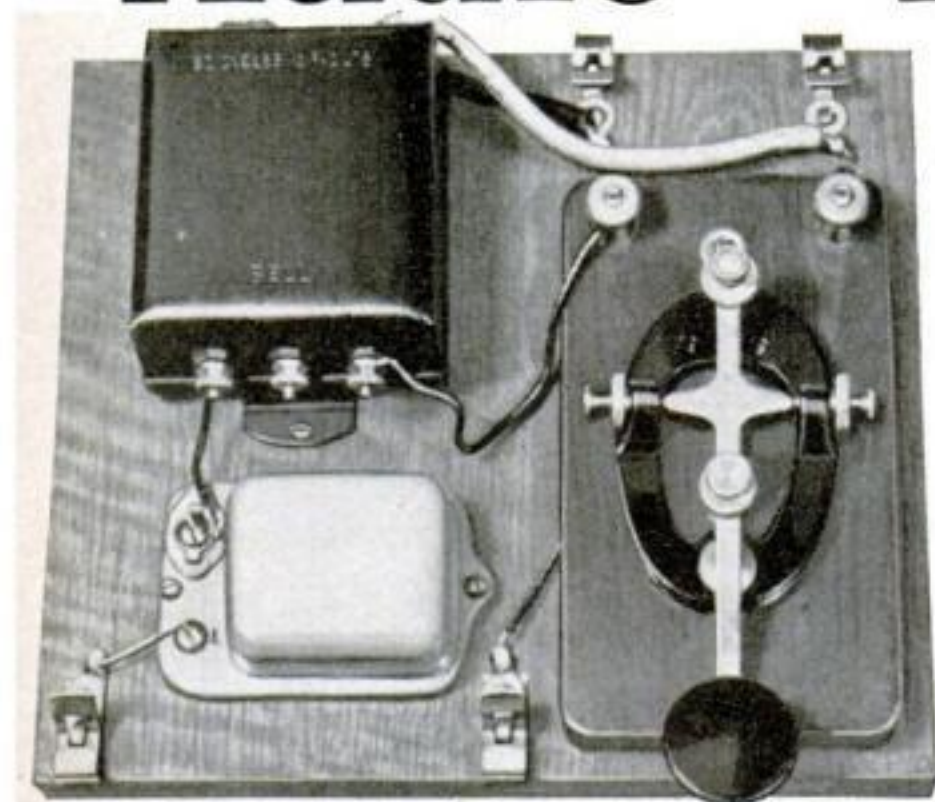
NEEDS NO WIRES

WITH a few inexpensive standard radio parts you can experiment with a new and novel type of communication system. Dubbed an "audio" telegraph because it uses waves that are more than 30,000 meters long, the easily built hook-up makes it possible to send and receive dot-and-dash messages over distances of more than 200 feet without the use of wires.

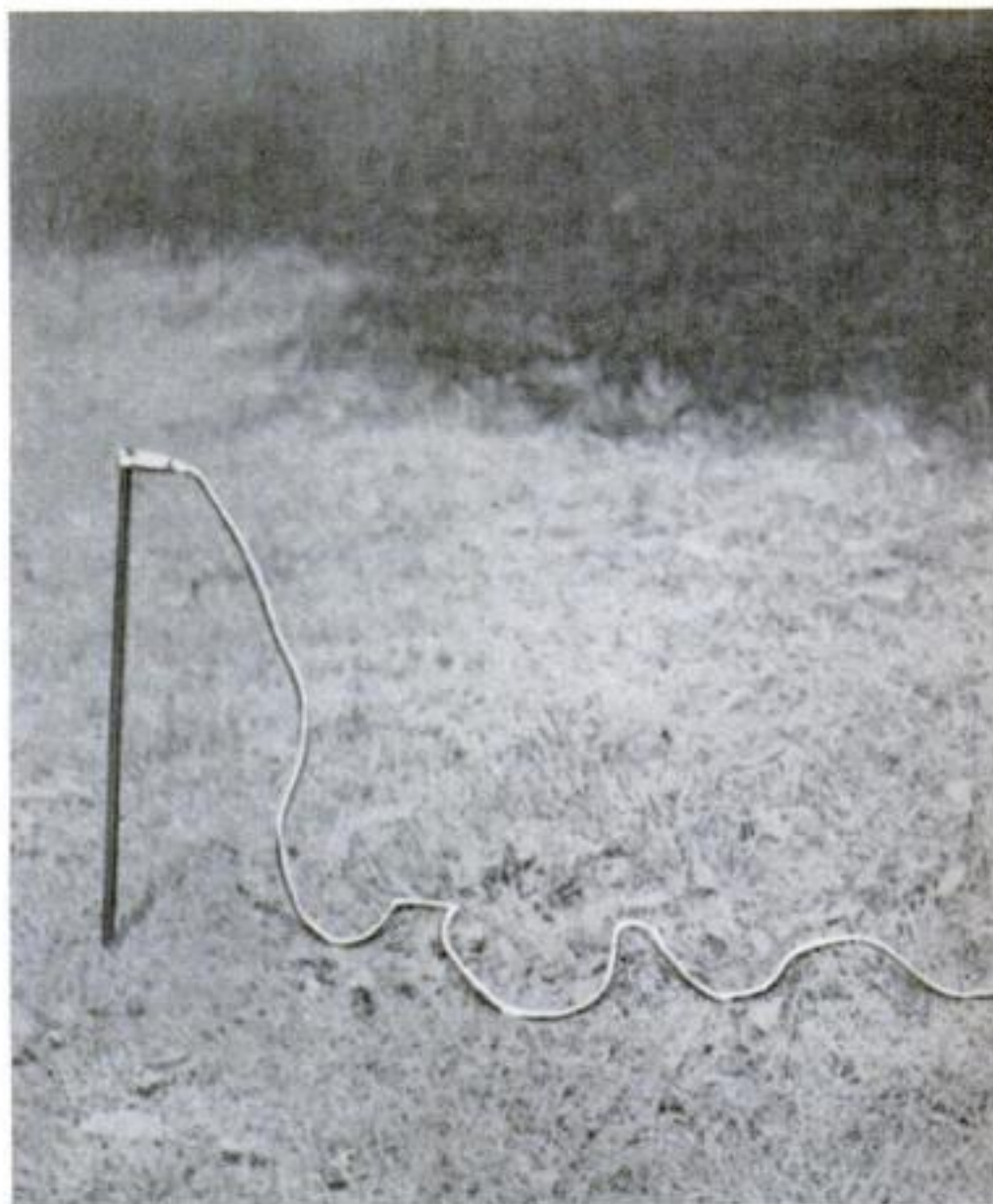
In the "audio" telegraph the ground serves as the connecting link between stations, the receiver and transmitter being connected to the ground by means of 30" copper or steel rods driven deep into the soil as shown in the photograph below. The transmitter consists simply of an eighty-cent telegraph key, a house buzzer, a battery, and a bell transformer. The receiver is an easily wired conventional two-stage audio-frequency amplifier connected to an ordinary pair of earphones.

In the original transmitter circuit shown,

Above, the transmitter, and at the right, the receiver, both mounted upon boards with Fahnestock clips used as terminals

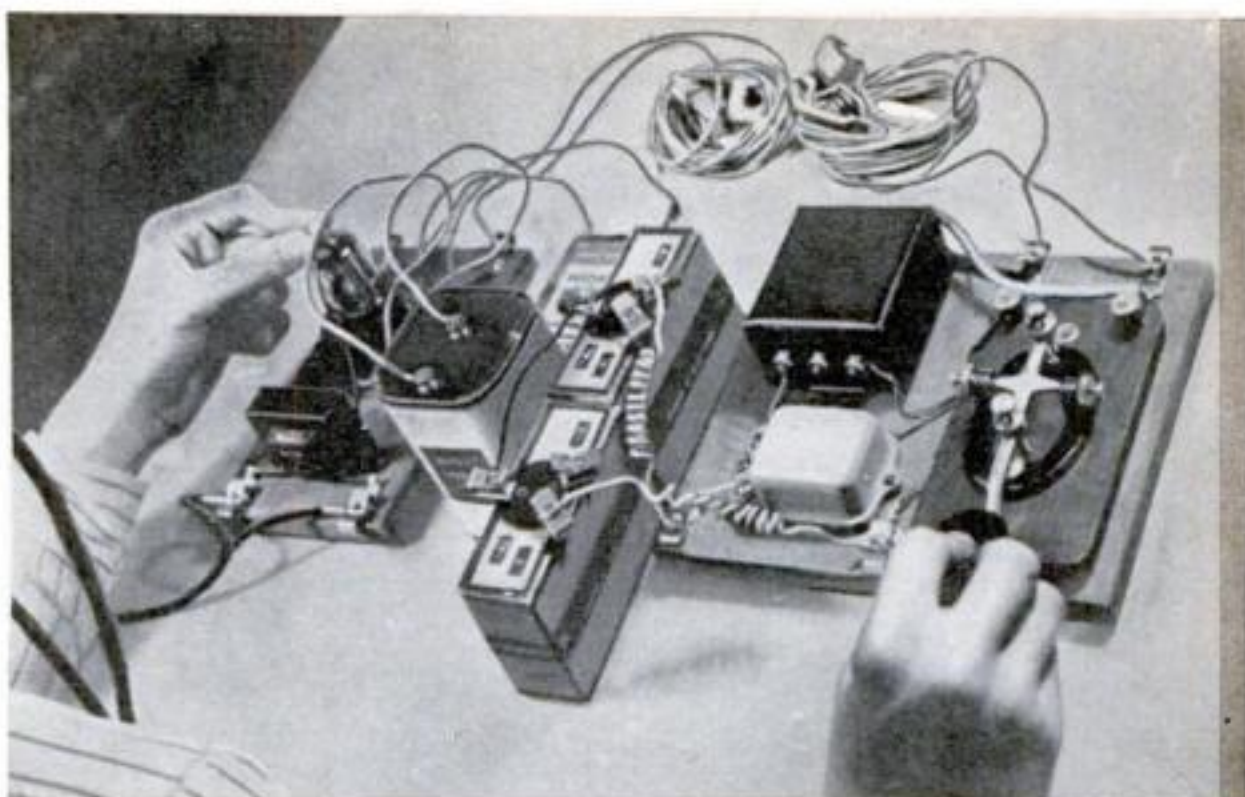


All connections are shown and all parts are represented in the wiring diagram of the receiver above. At right, sender and receiver are set up for use

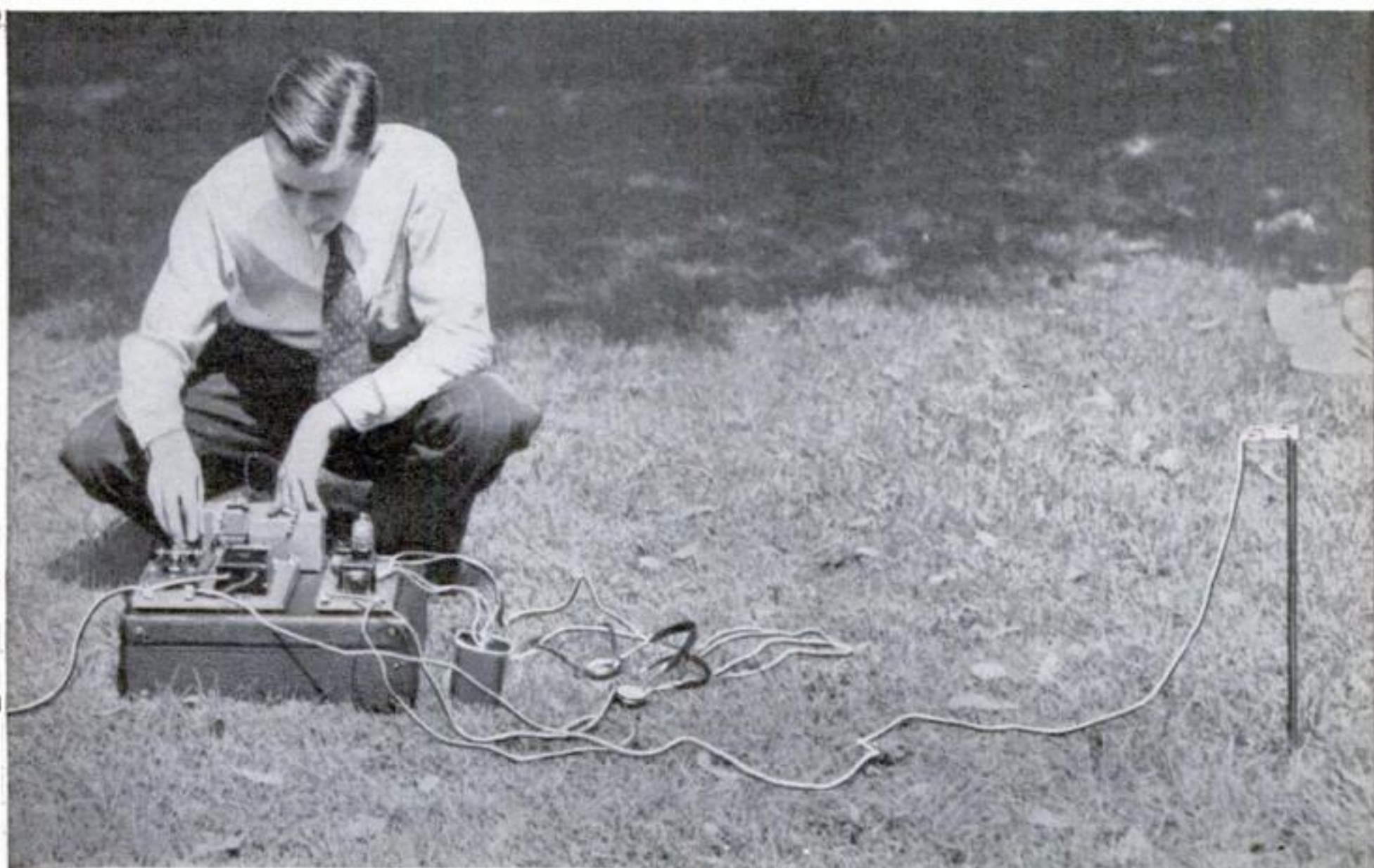
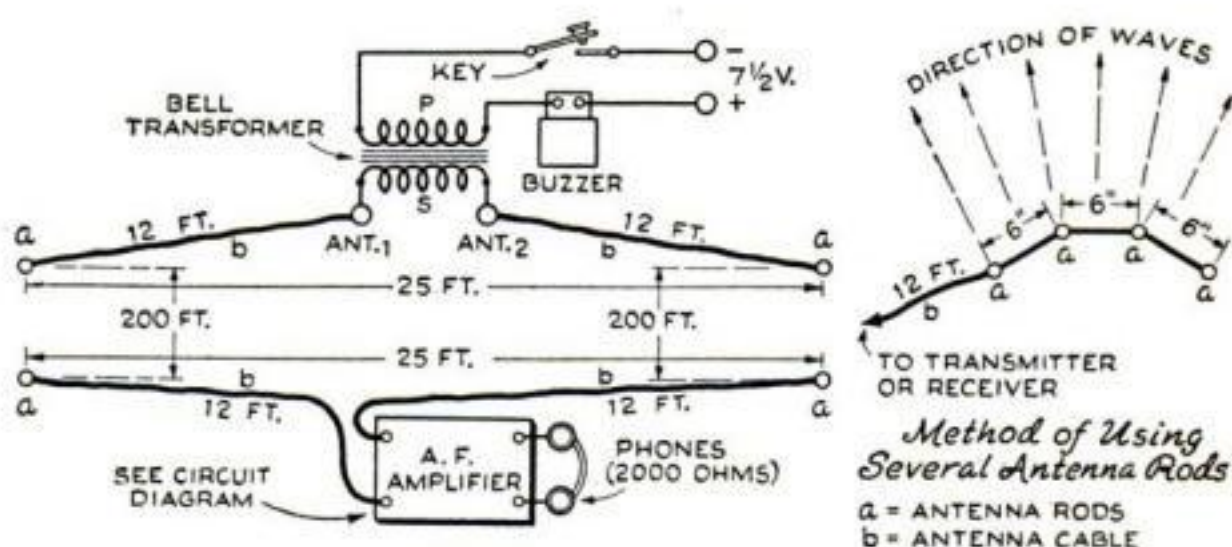


I mounted the parts on a 7" by 8" baseboard. It can, of course, be placed in a cabinet or it and the receiver can be housed together in a compact portable carrying case. When buying the bell transformer, which is the only critical part in the transmitter circuit, make sure that it provides a 110-volt primary and a 12-volt secondary. In the actual hook-up, the windings are used in reverse—the 12-volt winding serving as the primary and the 110-volt winding as the secondary. Connections to the copper antenna rods and to the $7\frac{1}{2}$ -volt battery can be made through Fahnestock clips screwed to the baseboard. (See next page.)

By
FRANK TOBIN



Follow this arrangement in mounting the parts of the two units on their baseboards. Below, how transmitter, receiver, and ground rods are set up





A small suitcase provides a handy carrier for the outfit, its batteries, and the necessary wires

For the audio-amplifier receiver, a dual-purpose 1D8GT tube is used. The diode portion of the tube provides the first or input stage, the pentode the second or output stage. Notice that an audio transformer is used in the first stage and resistance coupling is used in the second.

A small $1\frac{1}{2}$ -volt flash-light cell or an ordinary dry cell, and one 45-volt "B" battery, provide the current necessary to power the receiver circuit. These batteries are indicated on the wiring diagram together with the socket connections.

In setting up the receiver and transmitter, be sure to follow the directions given in the drawing. The antenna rods must be placed approximately 25' apart and in a line parallel to the line of the rods connected to the receiver. If a greater distance of transmission is desired, use additional antenna rods in the transmitter circuit and place them in open curves facing toward the receiver.

PARTS FOR "AUDIO" TELEGRAPH

Amateur transmitting key.
Bell transformer (see text).
House buzzer.
Audio transformer, 3-to-1 ratio.
Baseboard octal socket.
Tube (1D8GT).
Fahnestock clips (eight).
Headphones, 2,000 ohm.
Antenna rods (four, see text).
Mica condenser, .005 mfd.
Tubular paper condenser, .002 mfd., 600 v.
Carbon resistor, $\frac{1}{2}$ watt, 1 meg.
Carbon resistor, $\frac{1}{2}$ watt, 50,000 ohm.
Miscellaneous: Flash-light batteries, "B" batteries, wire, baseboards, etc.

Get Started IN Radio

ALTHOUGH designed primarily as a phonograph amplifier for use with either a crystal or a magnetic pick-up, this fourth circuit in the "Get Started in Radio" series which began in the September, 1940, issue, is so versatile that it can be used for other purposes as well. Connected to a simple crystal receiver through a 3-to-1-ratio transformer, for instance, it can be used to provide loudspeaker volume on near-by broadcasting stations. Used with a microphone, it can be made to serve as a small public-address system.

The parts for the amplifier were all included in the main list of parts given in the first article. If you bought the list complete you have nothing more to buy, for even the baseboard can be used again by turning it bottom side up to conceal the holes that were made in mounting



An earphone can be used as a public-address mike

PART IV... A THREE-TUBE AMPLIFIER

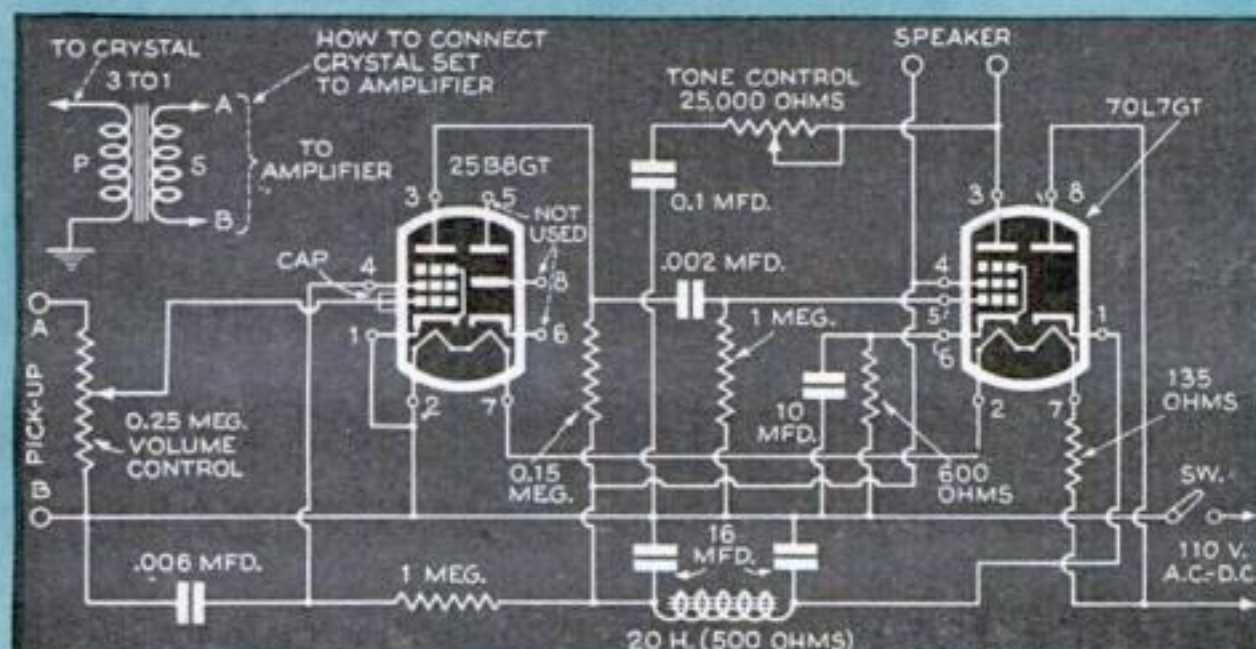
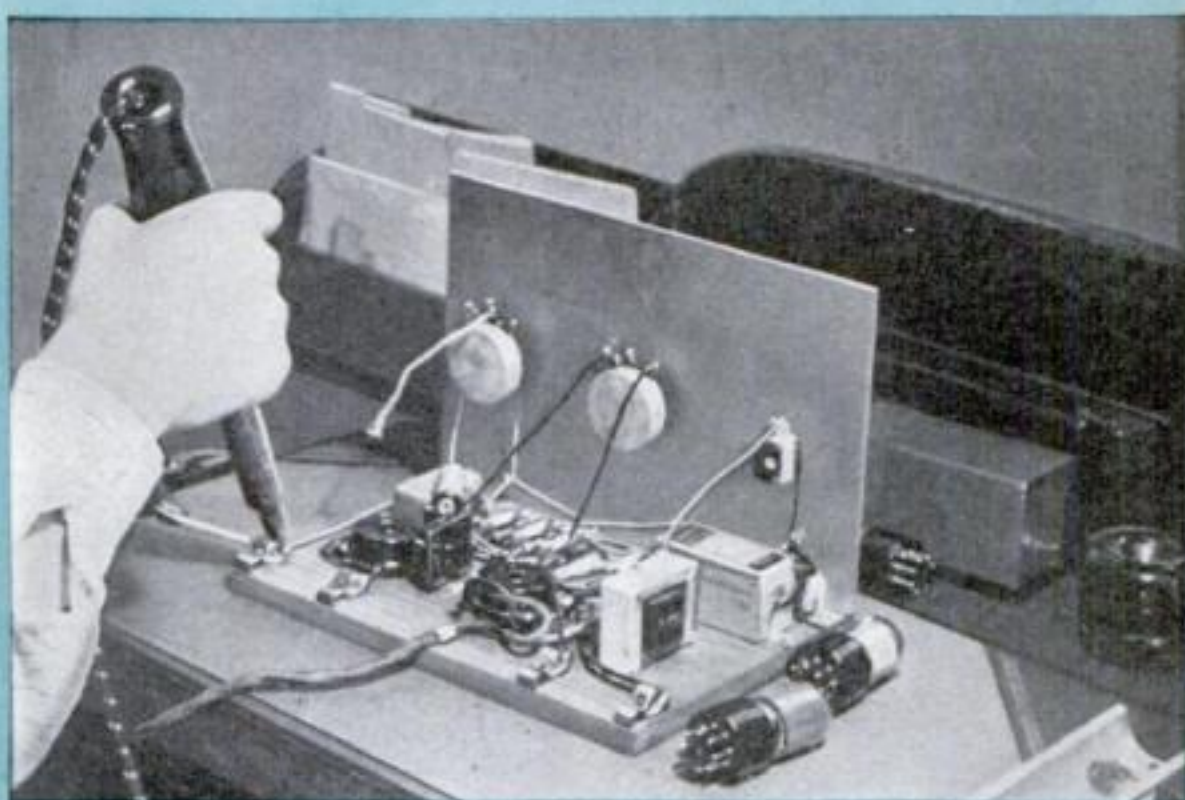
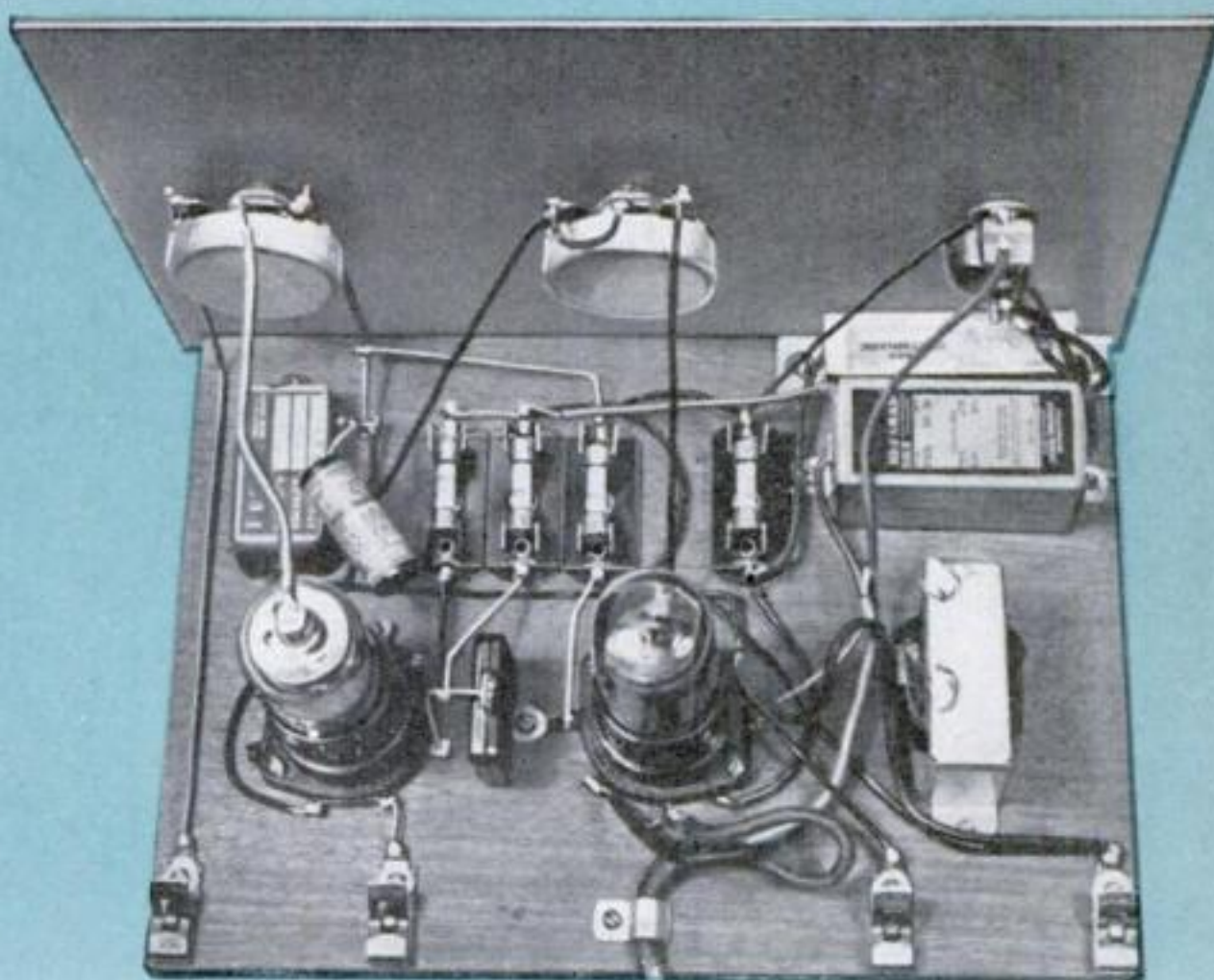
the parts for the first three circuits.

Your first job will be to take apart the four-tube receiver constructed last month. Be careful in removing the parts, as many of them will be used again.

Both tubes (25B8GT and 70L7GT) are used in the amplifier circuit. The 25B8GT, not using its triode section, serves as the input stage and the 70L7GT provides the output. As shown in the diagram, resistance coupling is used and offers sufficient volume for ordinary use.

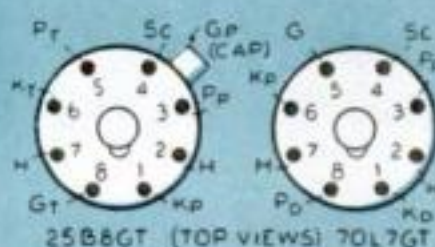
In placing the parts, follow the photographs. Mount the 25,000-ohm tone control, the 250,000-ohm volume control, and the on-off switch on the front panel. The volume control fits conveniently in the space vacated by the variable tuning condenser used in the previous receiver circuits.

When used as a phonograph amplifier, the unit should be connected to a high-impedance pick-up with a rating of approximately 18,000 ohms.



Soldering iron and pliers are the only tools needed to assemble the inexpensive amplifier

How the parts are wired. Below are the two socket wiring diagrams



NEW DEVICES FOR

Dial Light for Portable Radio

CONTROLS of battery-powered portable receivers, usually not illuminated, can be bathed in light when needed if a small fountain-pen flash light is fastened to an easily made clip screwed inside the cover.



New Snap-Button Binding Posts

DRESSMAKERS' snap buttons replace conventional plug terminals on a new lightweight, 67½-volt "B" battery designed to fit tiny portable radios. Plus and minus buttons are reversed to prevent mistakes.

Tilt-Front Radio-Phonograph Leaves Top Panel Free

HINGED at the bottom, the entire speaker grille on the front of a new console-model radio-phonograph swings out, drawing the turntable and pick-up-arm assembly for-

ward to a position where records can be easily changed. Besides making the phonograph accessible, the design dispenses with the large hinged top frequently found on console-type instruments and permits the top to be used for vases, books, and other decorative or useful objects. Tuning controls set in a panel above the grille are revealed when a small double-hinged lid is raised and folded back.



RADIO ENTHUSIASTS

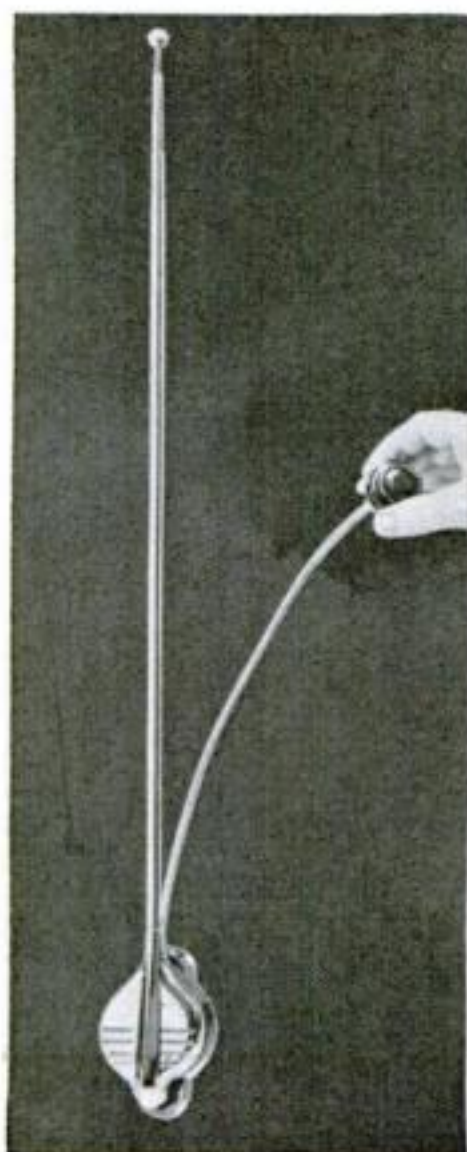
Tiny Transformer Matches Microphone to Amplifier

SCARCELY two inches long, a new microphone-cable transformer for public-address systems attaches directly to the input of the amplifier when it is necessary to couple a low-impedance mike with an amplifier having only a high-impedance input. Two types are available, one having a 30-50-ohm primary, and the other a 200-500-ohm primary. Each unit is said to be completely shielded against hum pick-up. The compact unit uses a high-permeability, magnetic-alloy core.



Knob on Dash Controls New Car Antenna

CONTROLLED entirely from inside a car, the new telescoping car-radio antenna shown at the right is easy to install and operate. Available in several models for installation either on the metal strip dividing some windshields, or on a windshield pillar or the side of the cowl, the antenna is controlled by means of a knob attached to the dashboard. Turning the knob raises or lowers the antenna to the exact height desired for peak reception.



Carrying Strap Is Antenna for New Midget Portable

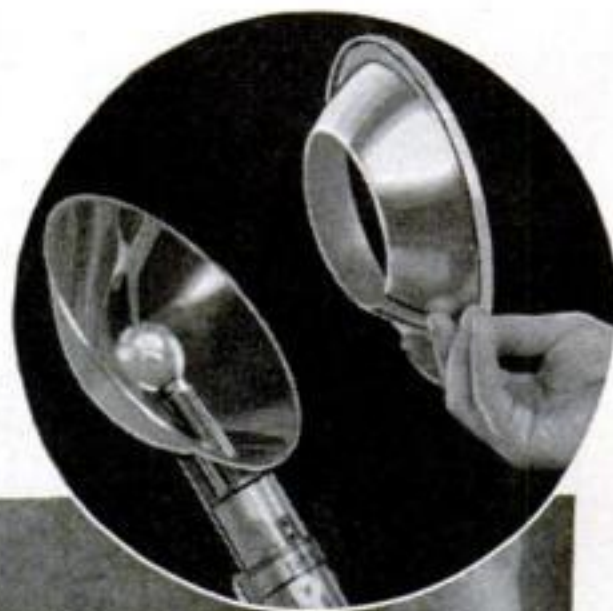
WEIGHING only four pounds, a recently introduced portable radio resembling a miniature camera is carried by means of a shoulder strap containing a specially designed loop antenna. The plastic cabinet houses a four-tube superheterodyne receiver powered by a single, long-life battery. A permanent-magnet speaker provides good volume and tone.

LATEST AIDS FOR



New Double-Purpose Reflector

HAVING a removable inner shell, a novel photo-flash reflector enables the user to choose between two types of illumination when he is making pictures after dark or under poor lighting conditions. The reflector has a conventional outer shell of highly polished chromium. When it is used alone, a wide beam is given off by the reflector. The inner shell, with a circular hole at the center, has a rough "satin" finish. When this auxiliary shell is in place, the highly polished portion of the outer shell, under the circular opening, reflects the light and throws a concentrated beam that gives the same effect as a spotlight.



Midget-Type Flash Bulb Comes in Handy Carton

PROVIDING a brilliant stab of light, a new midget wire-filled photoflash bulb is now available to camera fans. Only two inches high, the little lamps are sold in compact ten-bulb packages which can be carried in a coat pocket. Each bulb is equipped with a bayonet base. In the photograph above, one of the midgets is compared with a 1937-model bulb of the same brilliance. The new bulbs are scientifically shaped to throw an even pattern of light.



Master Foot Switch

THREE outlets on the electric foot switch at the left make it useful for many photographic jobs. Two outlets in the top, which are turned on when the treadle is pressed, can be used to operate photoflood lamps, or an enlarger may be plugged into one of them. A third outlet, in the end, is "on" permanently and is handy for a clock or safe-light. A red pilot light makes it easy to find in a darkroom.

THE CAMERA FAN

Homemade Photo Match Books

HOMEMADE match books, with favorite snapshots reproduced on the covers, are now possible for any amateur who has access to a darkroom. An eastern manufacturer has placed on the market sensitized cardboard books which can be purchased in quantities of fifty or more. By contact printing, the picture is recorded on the covers of the book. After the photograph is fixed and dried, the book is folded and the matches inserted.

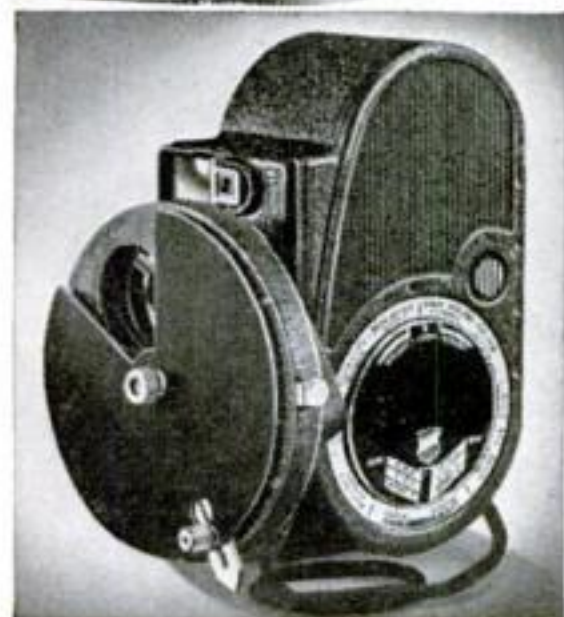


Any negative may be printed on these match covers



Water Runs Film-Tank Agitator

WATER does the work of rocking a developing tank, to agitate the chemicals and insure even development, when a new teeter-totter is placed under the stream from a kitchen faucet. The tank rests on one end of the device while water flows into a troughlike compartment at the other. When the trough fills, the weight tips it down, the water rushes out, and the empty trough rises and is filled again. The agitator, made of acid-resistant metal, accommodates all sizes of roll-film tanks.



Graduated Disk Fades Movies

A ROTATING disk, graduated from transparency to opaqueness, enables the home-movie maker to produce fade-ins and fade-outs. Simply by turning the disk, he decreases or increases the light reaching the film.

Enlarger Lamp Also Serves As Safelight

COMBINING the duties of safelight and enlarger lamp, a tinted bulb used in a recently marketed enlarger is in direct contact with the air, thus speeding up the dissipation of heat and eliminating any possible damage to the film due to overheated metal in the enlarger housing. The exposed red upper surface of the bulb gives off a light which, according to the manufacturer, will not fog even the fastest enlarging papers.



By
**JOHN H.
WOOD**

After the title is shot upside down, a tiny peg is pulled away and the reel rolls down the sloping track. The film is turned around when it is spliced in place so that the title appears to roll into view and then stop.



Action Titles

PEP UP YOUR MOVIES



A photograph or enlargement of the first frame of a scene makes an excellent title background.

TITLES containing or implying action do much to improve home movies, and making them can be just as much fun as shooting regular scenes. You can easily devise many ingenious titles your audience will be certain to appreciate.

Taking a picture of a title upside down, then turning the piece of film around and splicing it so the action is reversed is an old trick, but one for which new variations are constantly being contrived by 16-mm. movie makers. Charles H. Taylor, of Chicago, suggests two such variations.

In the first, titles roll into the picture on movie-film reels. To perform this stunt, support a yardstick across the back of two chairs placed before a plain wall, and fasten pieces of cardboard to the thin edges of the stick. Let the edges of the cards extend above the surface of the stick about $\frac{1}{8}$ " so as to form a shallow trough for the reels. The letters, which may be paper, metal, or plastic, are fastened to the reels with rubber cement, wax, or even chewing gum.

Place the reel or reels, as the case may be, so that the desired word or phrase is spelled upside down. Elevate one end of the yardstick slightly and place a toothpick or pin tied to a thread in front of the reel. Shoot the title long enough to record the word, then pull away the toothpick and the reel will roll out of the scene. When the film has been processed, splice in the title backwards.

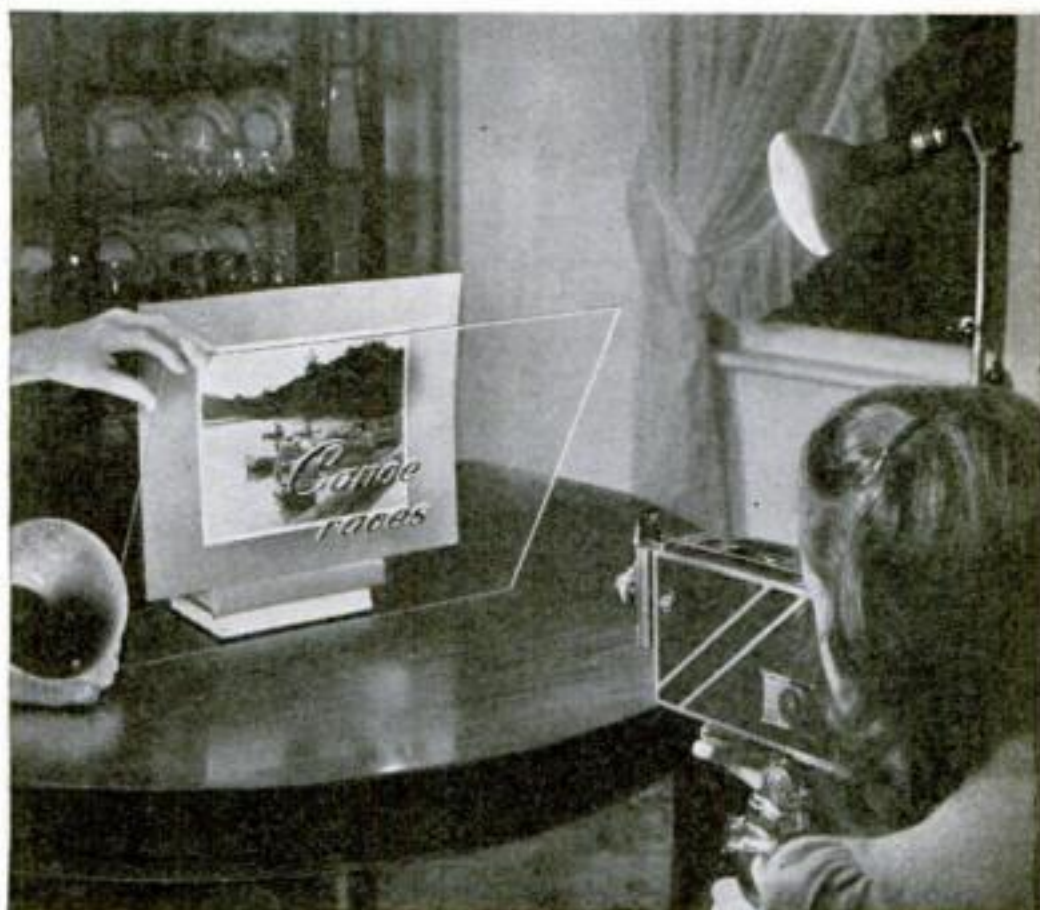
Mr. Taylor's second trick produces the effect of a revolving reel unwinding film that moves across the screen to spell out the title. Support a large piece of cardboard across a doorway or between chairs as shown. Starting with the first letter of the title, push long pins through from the back so they go through the track perforations and hold the film in place. The title must, of course, be upside down.

Wrap several layers of adhesive tape around a pencil so the reel fits on it tightly and can be turned from the back. Arrange the lighting to cast shadows and thus give thickness to the letters. Number the pins on the back of the cardboard so your assistant knows in what order to pull them. Shoot the title long enough to be read, then start removing the pins and winding the film onto the reel.

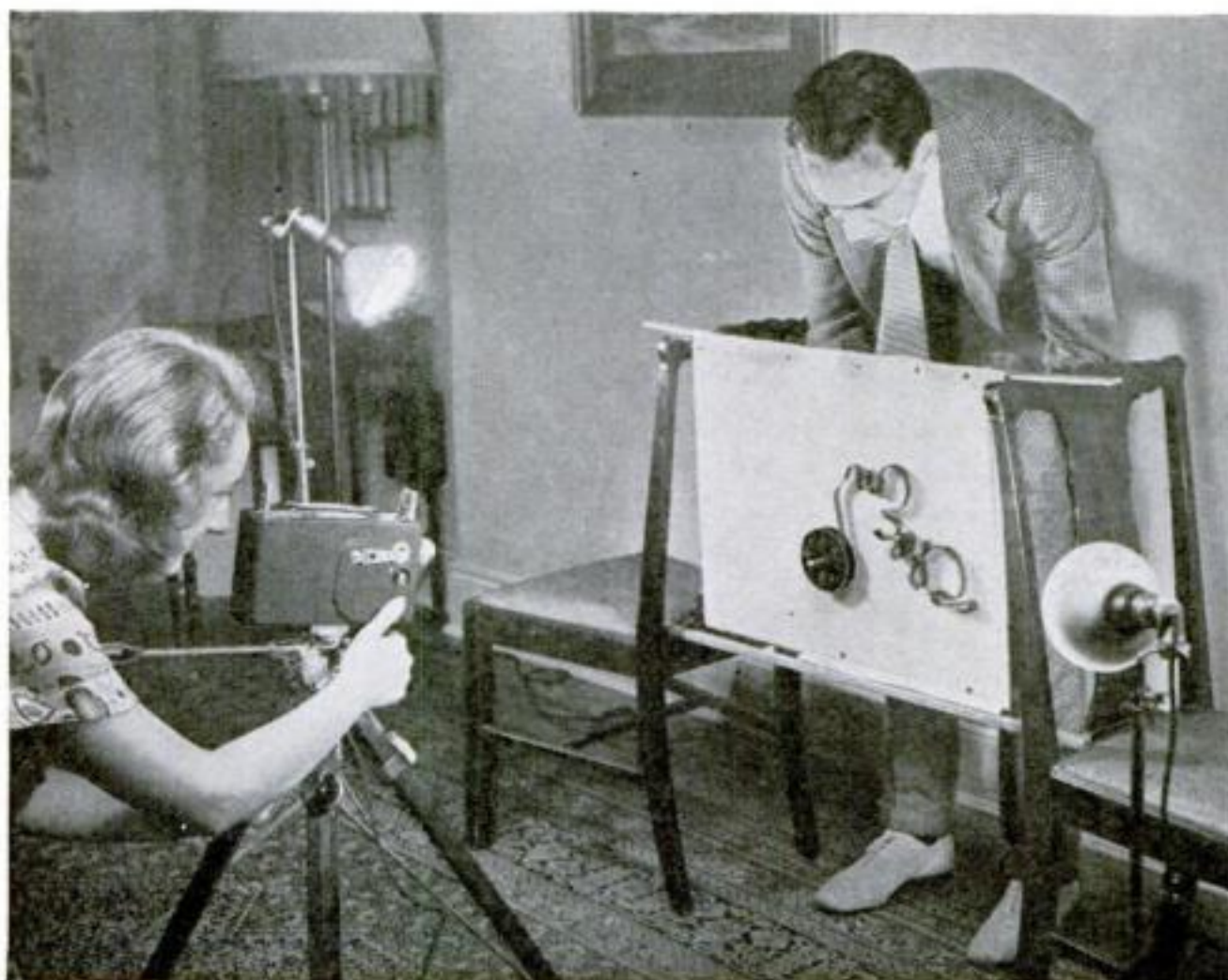
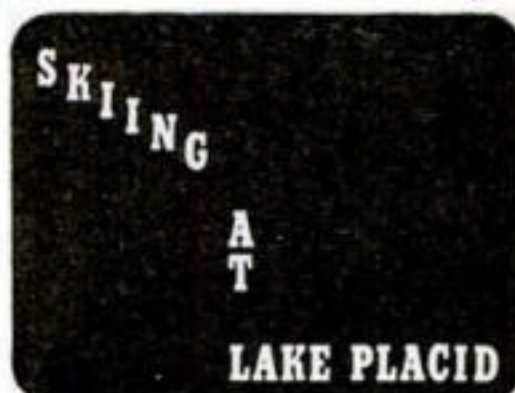
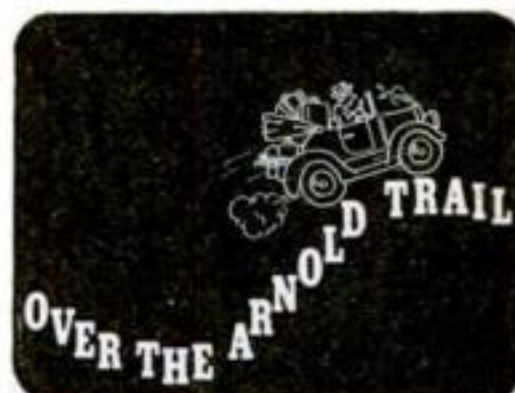
Photographs, magazine illustrations, and even pieces of wall paper often provide appropriate backgrounds for titles. Sometimes an exceptional effect can be obtained by using an enlargement of the first frame of the scene. The audience then sees a title against an attractive background which suddenly comes to life when the words disappear. Lighting of photographs

must be done very carefully if they are to look realistic.

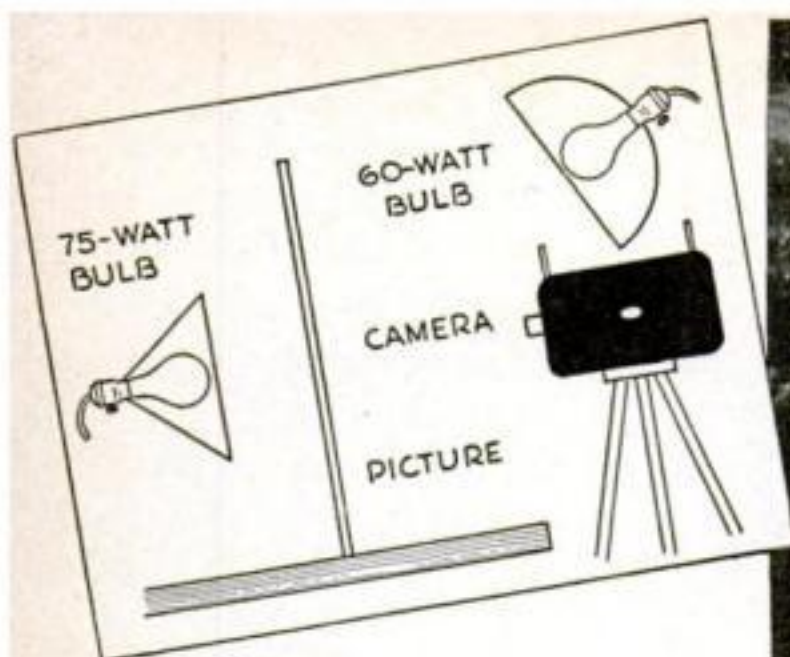
A "double-exposure" title can be obtained by printing (or typewriting) the wording on the back of a photograph made on single-weight paper. Illuminate the title from the



With this set-up, the picture is photographed; then a title printed on glass is swung into position. The words will be distorted until the glass is vertical. Right, action can be implied by a clever arrangement of the letters. Here are three illustrations.



At left, as the film is wound on the reel, pins holding the letters in place on the cardboard are pulled from the rear



Arrangement for a "double-exposure" title. Printing is on back of picture. As the back light is brought closer to the picture, the latter becomes visible



front and start the camera; then gradually bring a brighter light up in back of the title so the picture shows through. With ordinary panchromatic film and an exposure of $f/3.5$, a 60-watt bulb in front and a 75-watt bulb in back of the picture should be sufficient. You can cut down the diaphragm opening by using photofloods. If you want to use an enlargement of the first frame of the scene as a background, the picture must be printed backwards.

The action in the scene to follow a title can often be implied by a clever arrangement of the letters. Several examples are shown.

If you letter the title on glass, actual scenes may be used for the backgrounds. First focus on the title, then gradually bring

the background into focus. Remove the glass and continue the scene. Another idea is to start photographing a picture, then swing a glass with the title on it up into position over the picture.

The stop-action technique has many applications. With this method, a single frame is exposed (the camera is set at half speed and the button tapped quickly), then a slight change is made in the scene, a second frame exposed, another slight change made, and so on. Toys can be made to move about, and people appear or disappear mysteriously. If this is done carefully, smooth action will result. One movie amateur made a very amusing film on animals. The titles were written on a blackboard, and toys "pranced" about in front of each title.

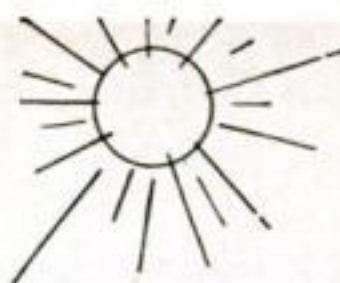
FERROTYPE HINTS

[PHOTOGRAPHY]

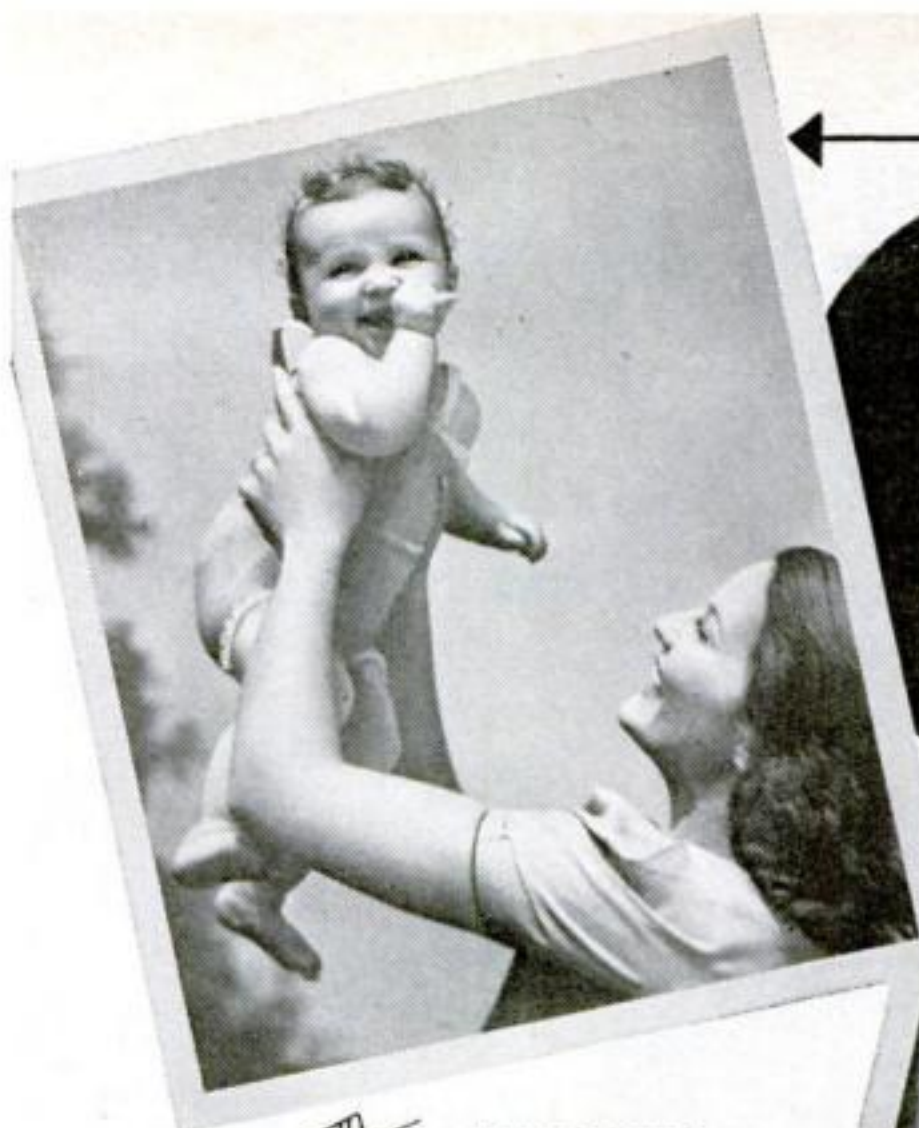
Stale hypo baths, containing exhausted hardening solution, cause much of the annoyance arising from prints sticking to the ferrotype plates. . . Do not use heat to hasten drying of prints on black enameled plates. . . A small piece of beeswax or paraffin, dissolved in a few ounces of gasoline, is a cheap but good polishing solution. Apply with a small cloth, let dry to a matte surface, then polish with a clean, soft cloth. . . Wrinkled prints, caused by the wet prints pushing ahead of the roller, may be avoided by placing a heavy blotting paper over the prints and holding it firmly while rolling. . . If short of ferrotype plates or time, dry the extra prints face down on a towel after washing, then resoak and ferrotype them later at your convenience. . . . If prints are soaked for about five minutes in a ten-percent solution of glycerin, it will give them a more pliable "feel" and also reduce sticking and curling.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

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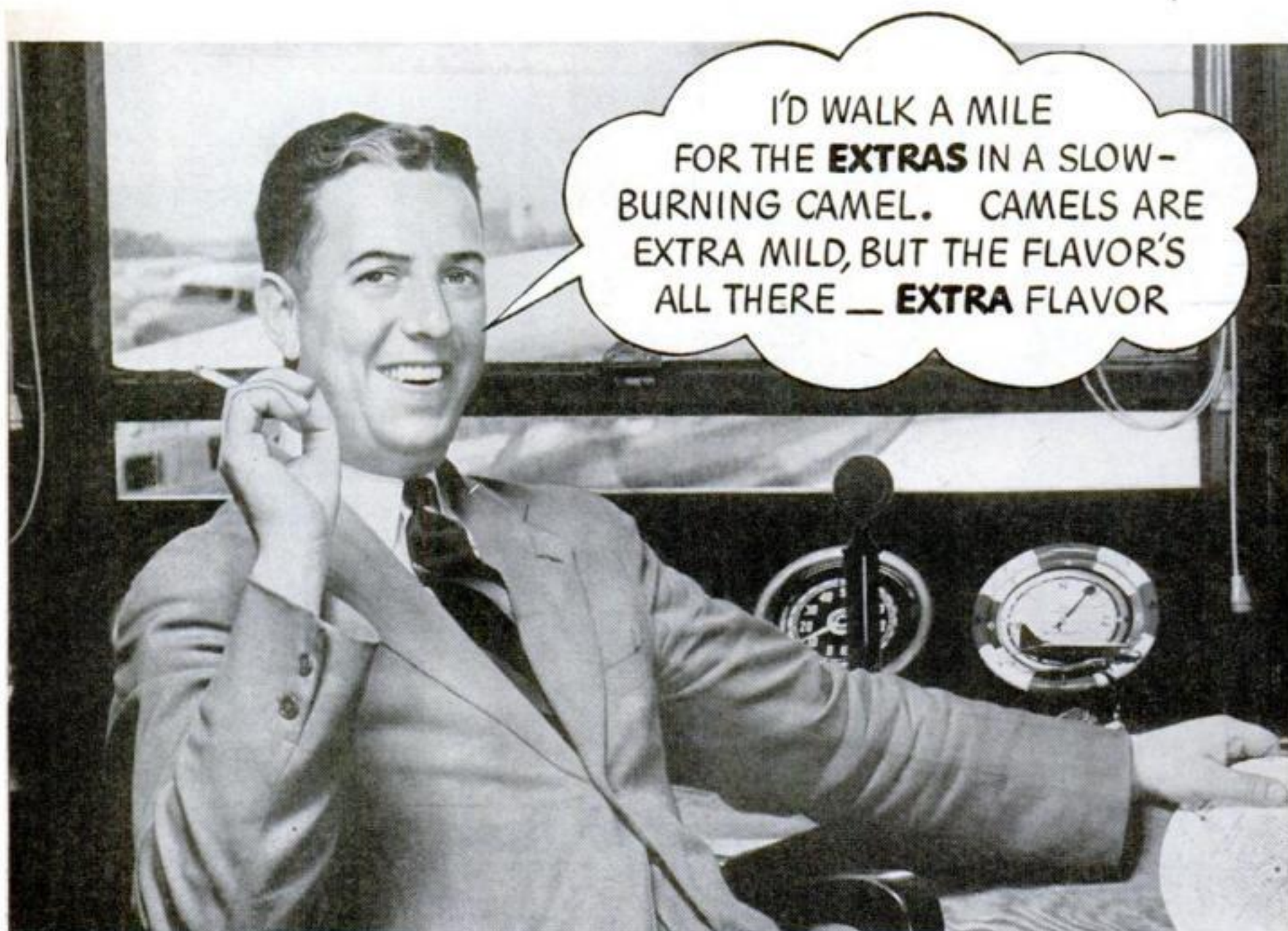
B... Use a couple of inexpensive Mazda Photoflood lamps in Kodak Handy Reflectors

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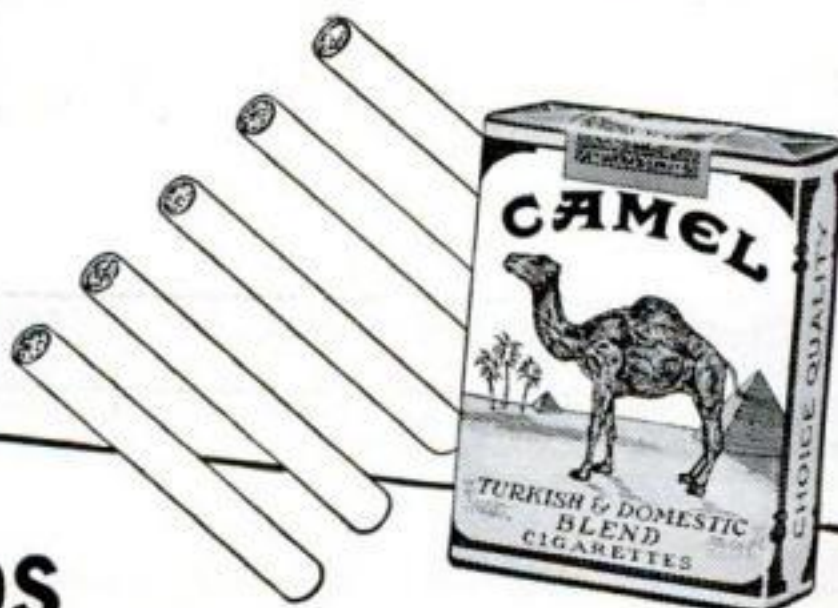
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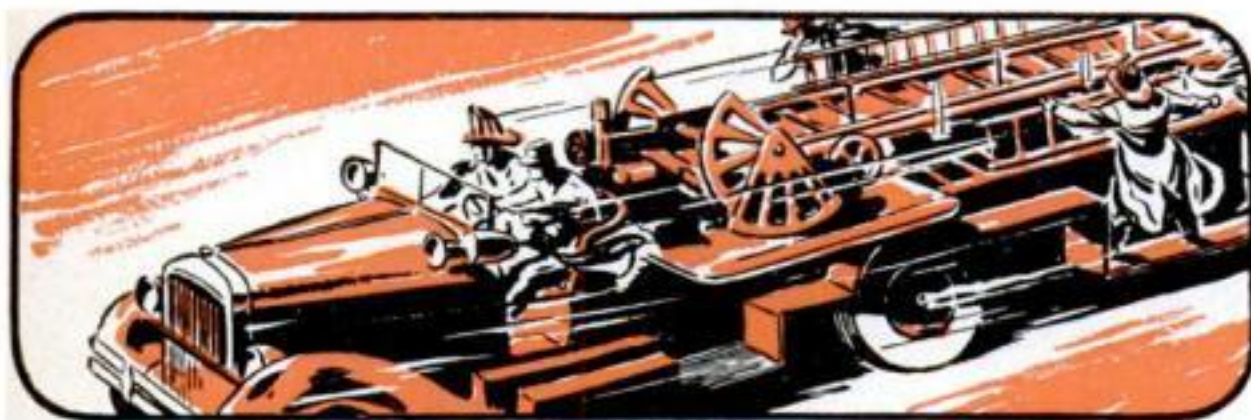
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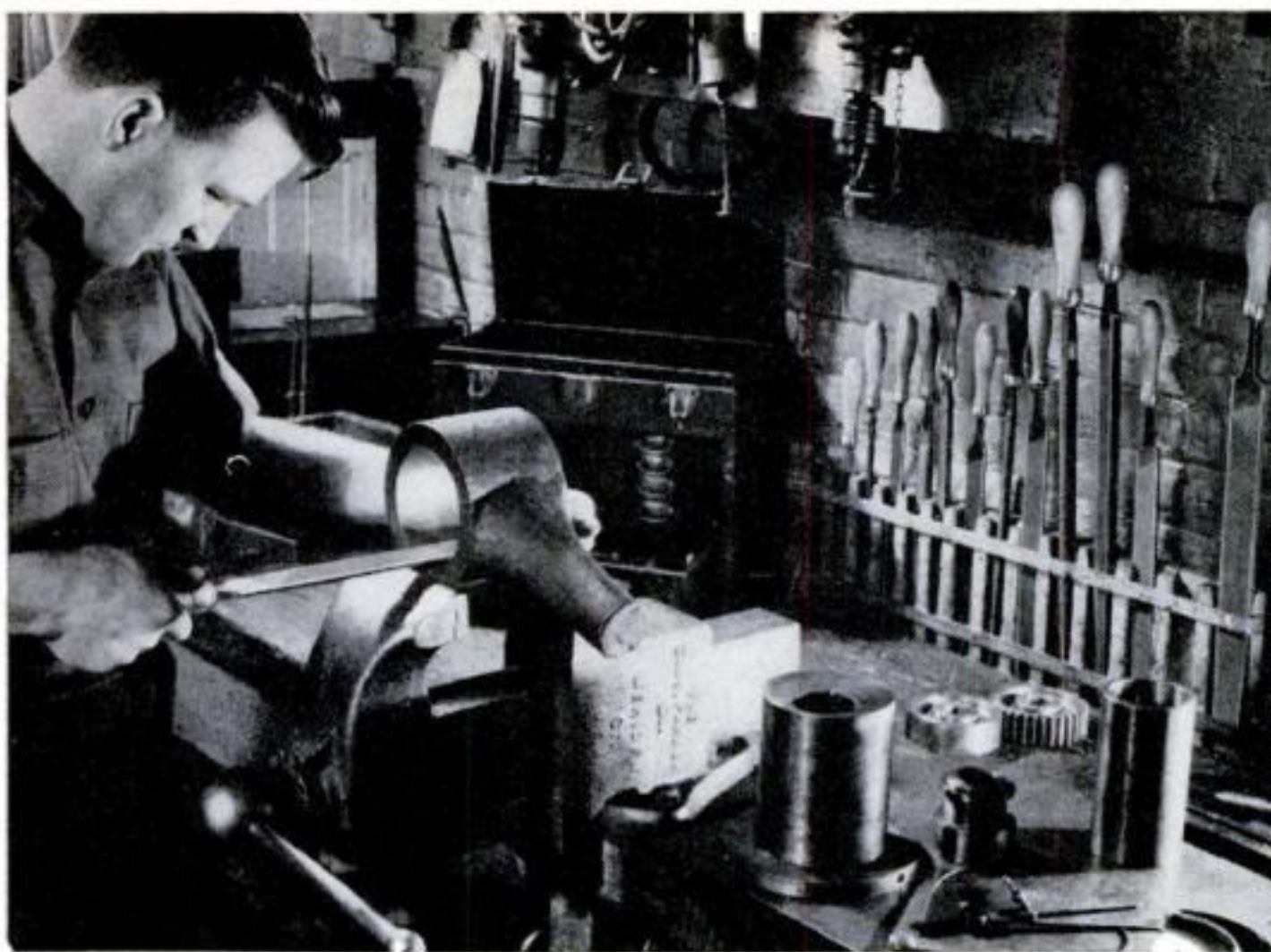
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(Continued on page 222)



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(Continued from page 220)

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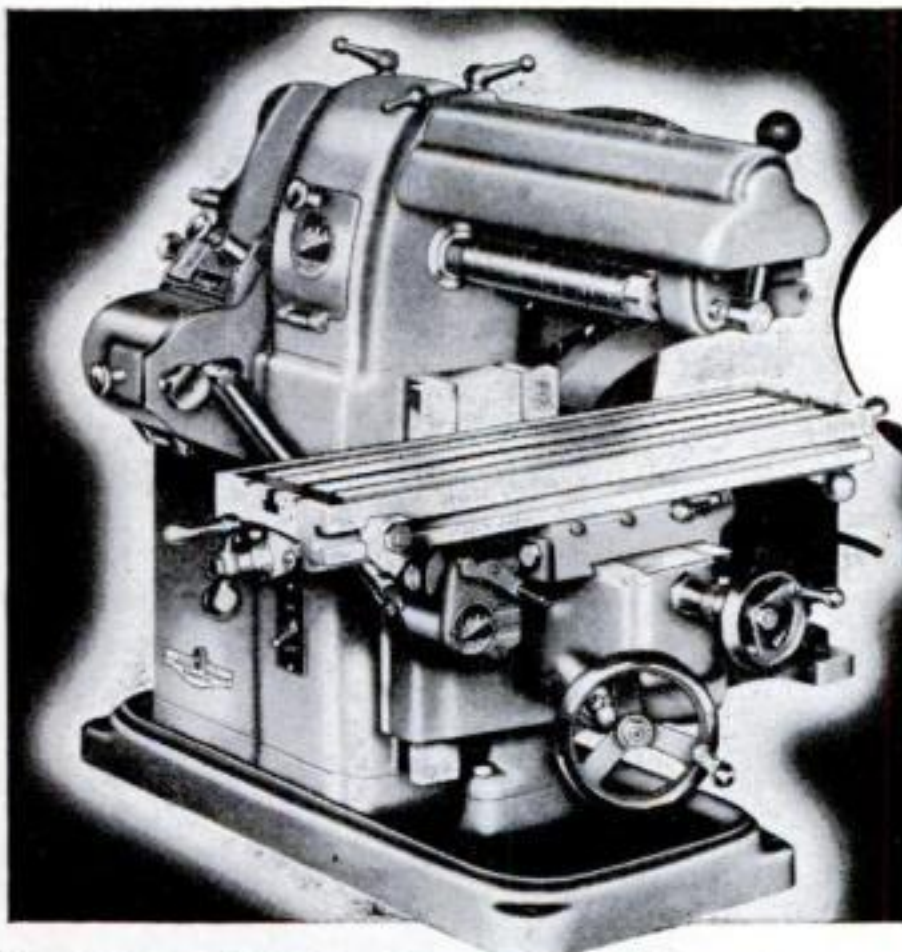
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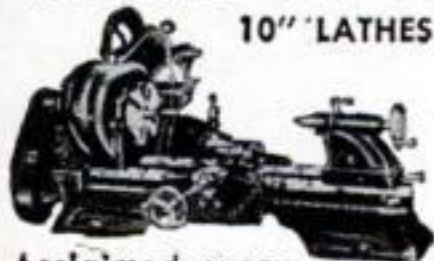
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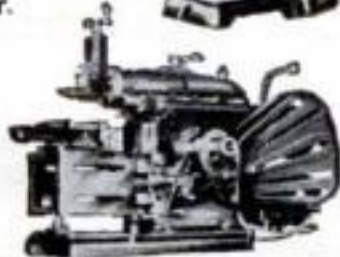
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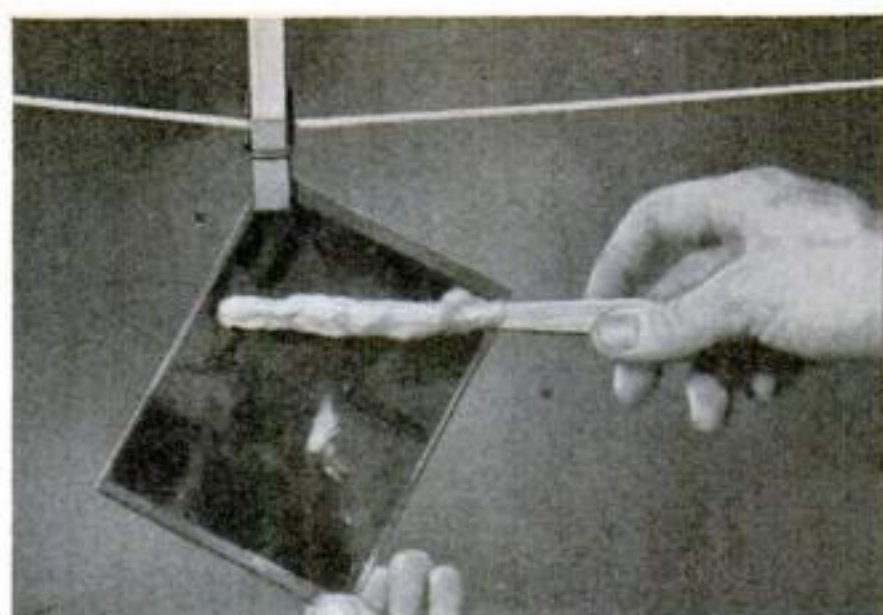
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How to Wipe Wet Negatives Without Scratching Them

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MINIATURE 35-mm. double-frame film may be stored conveniently in the original cans without danger of finger marking or scratching if it is first rolled around a cork and secured with a rubber band. The cork serves as a handle.

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RODS for stirring and crushing photographic and other chemicals can be made from ordinary five-cent plastic penholders. Cut a short piece from the large end of each in order to remove the portion that is drilled out. These stirring rods will not break and are not affected by the chemicals.



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Here is the only drill press that because of exclusive patents gives you the combination of BOTH Self-Aligning Drive and Free Floating Spindle that guarantees accurate alignment. Other features include: "Sealed-for-Life" Ball Bearings that require no lubrication for the life of the bearing; Graduated Quill; Adjustable Depth Pointer; Tilting Table with Index Pin and many others. For the complete story, specifications and low prices, see the latest Delta catalog.



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To insure true running of revolving parts, such as on pulleys and wheels, Delta uses a special operation known as "Dynamic Balancing."

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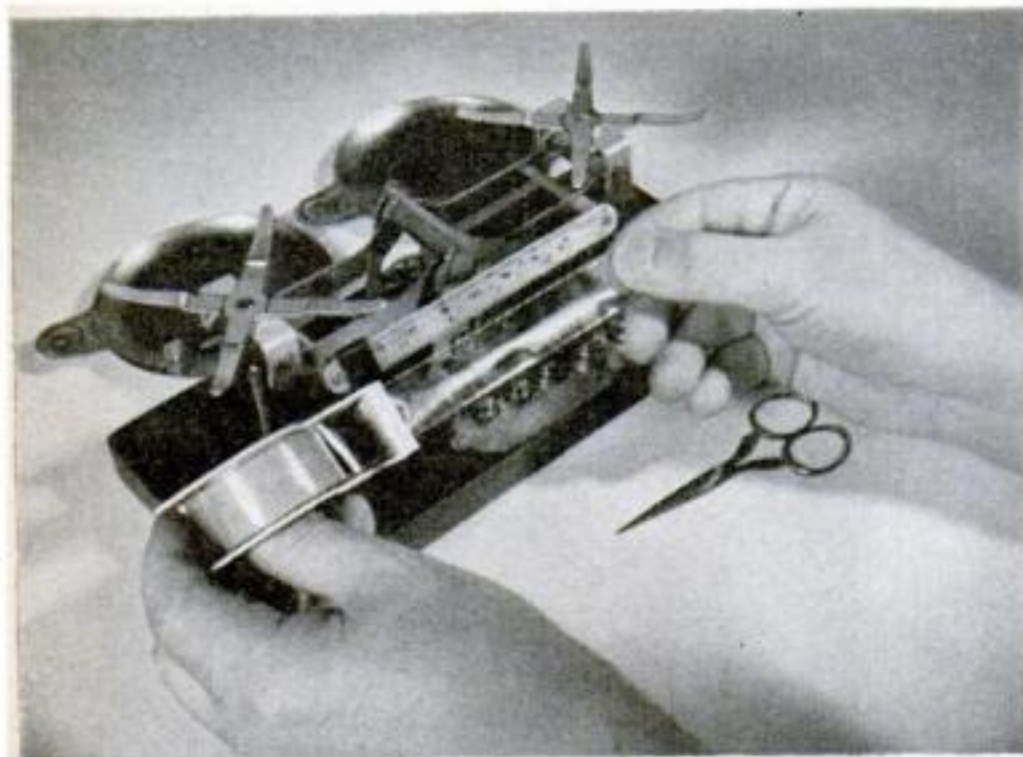
PHOTOGRAPHS of extraordinary depth of focus can be obtained by inserting a pinhole iris between the front and rear elements of certain types of camera lenses. The sculptured figure ornament in the upper right-hand corner of the accompanying night scene was about two feet from the camera, yet it is as sharply defined as the distant buildings and lights in uptown Manhattan.

To prepare the camera, the rear element of the lens was unscrewed, a disk of black paper was cut out the same size, and the center was pierced with a fine needle. The



New York night scene taken through a pinhole iris used with a Zeiss Tessar Anastigmat lens; 15 minutes on Super-XX film

disk was dropped into the lens barrel and held flat by replacing the lens element. This, in effect, provided a new diaphragm stop equivalent to $f/531$. The lens used was a Zeiss Tessar Anastigmat, $f/4.5$.



TAPE PROTECTS FIGURES ON A DARKROOM SCALE

AFTER a darkroom scale has been in use for a time, the division marks and figures engraved on the beam are likely to become indistinct because of unavoidable corrosion caused by some of the chemicals used. This can be prevented by covering the face of the beam with a strip of transparent cellulose tape, which will not interfere with the movement of the sliding weight. If the tape becomes worn, it may be replaced with a new piece.—K. M.



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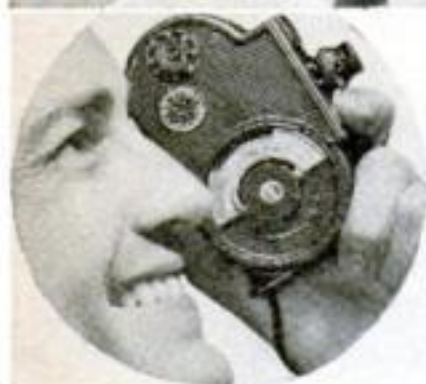
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Soldiers in Overalls

(Continued from page 88)

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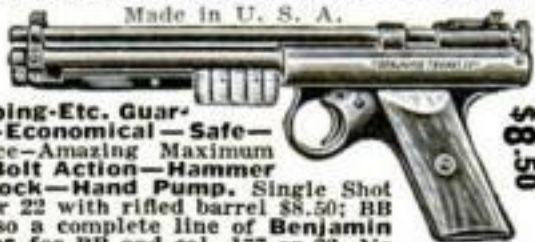
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He Invented the World's Deadliest Rifle

(Continued from page 71)

meeting was an offer to turn Garand loose in a room at the Bureau of Standards and let him prepare a working model of his gun. The salary was just half what he was receiving as a skilled machinist. But he jumped at the chance.

For eighteen months, Garand buried himself in the room set aside for him. At the end of that time, his gun was finished. But so was the World War, and the demand for machine guns was at a standstill. However, the U. S. Army had become interested in developing a light, semiautomatic rifle, a sort of compromise between a machine gun and a Springfield rifle. Garand moved to the Armory in Massachusetts and tackled the job.

That was twenty-one years ago. Ever since, the struggle to make this radically new weapon simple enough, strong enough, and light enough, has continued. These three problems were in the back of Garand's mind night and day—when he was working, lying in bed, playing table tennis or badminton or horseshoes. Often he came down to the Armory on week-ends and in the quiet of the great brick buildings wrestled with the toughest riddle of all, cutting weight to a minimum.

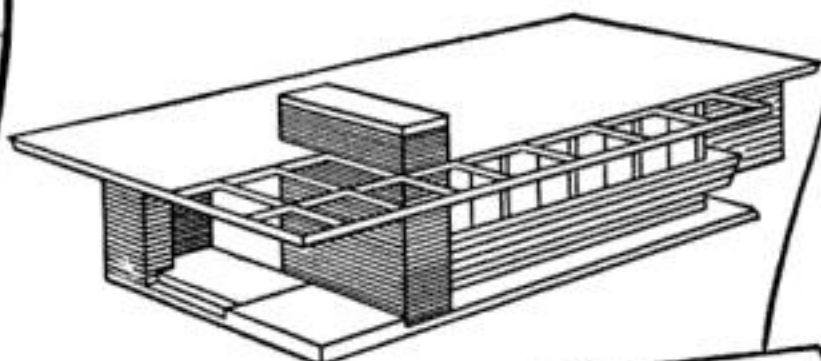
There were many times when Garand was positive the weight requirement set by the Army could never be reached. Eventually, by saving an ounce here and an ounce there, without sacrificing strength, he attained the goal. Most of the weight elimination was accomplished by reducing the number of parts. For example, one spring in the hammer mechanism now does the work that originally required five springs. That mechanical short cut, alone, clipped a whole pound from the weight of the gun. Gas pressure produced by the discharge of the cartridge automatically ejects the shell and cocks the gun, so all the operator has to do is pull the trigger. In other words, Garand has put the "kick" to work and by so doing has given American soldiers the best high-speed firearm on earth.

Along the road to this goal, model after model was designed and worked out with infinite care, only to be rejected after grueling tests. Nearly a dozen kinds of gun steel were tried, and the rear sight alone was redesigned fifty times. The present Garand gun combines the best features of half a dozen discarded designs. All during these years, other inventors were bringing forth ideas in

(Continued on page 236)

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He Invented the World's Deadliest Rifle

(Continued from page 235)

competition with the rifle Garand was making. His weapon won out over approximately fifty different models which were suggested or submitted to Army experts.

In those last hectic days when the Armory was rushing through a batch of the new guns for large-scale tests, the workmen labored in two shifts, night and day. Garand worked both shifts, sleeping when he could. Then came the most strenuous tests ordnance experts could devise. The gun was fired almost continuously, far beyond the limits of ordinary use. It was soaked in water and thrown in mud. It was even placed in a sand-blast machine for hours to see if any of the quartz grains would penetrate the mechanism. The rifle passed these torture tests with flying colors.

Garand has turned down tempting offers from a commercial company and a foreign government in order to give the United States exclusive rights to manufacture his rifle. For the price of one destroyer, the whole U. S. Army can be equipped with the superguns.

This, then, is the story of the man behind the Garand rifle—the story of a former motor-cycle racer, crack shot, boy inventor, and toolmaker who, without benefit of a formal education or an engineering degree, made firearms history. His two decades of concentrated application have produced a weapon which promises to be of outstanding importance in American defense.

"Miracle Measure" Gauges Thickness of Rust

Thickness of rust or weathering on sheets of iron can be measured to less than a hundred-thousandth of an inch, by a method developed recently by the Bell Telephone Laboratories in New York City. A short iron rod with two coils of wire on it is pressed, end on, against each side of the coated iron sheet. Both rods are magnetized by passing an alternating electric current through one of the coils on each rod. This induces a current in the other two coils. The coating, which is nonmagnetic, reduces the induced voltage on its side of the sheet by an amount that depends on the thickness of the coating. The method can also be used to measure the thickness of coatings of paint, paper, or other nonmagnetic materials. It is done without disturbing the coating.

Gus Gets Ready for Winter

(Continued from page 150)

to get a trunk tag and write on it and then tie it on your filler cap so that gas-station attendants won't add unneeded water. If you do any long-distance driving during the winter, you should have your radiator level checked about once a month."

"I know those \$2.65-a-gallon antifreezes are good," Ez said. "But how about the cheaper ones? A feller was tellin' me the other day that he only pays a buck a gallon, an' that the stuff does the work."

"Antifreezes are like most other things—you get just about what you pay for," Gus replied. "The base of most of the dollar-a-gallon mixtures is high-test methanol—wood alcohol—with something in it to prevent rust and corrosion. But methanol evaporates—which means that you have to keep watching your mixture, and keep adding to it."

"How about plain alcohol?" Ez wanted to know. "We always used to use it, and it did the trick."

"It will keep water from freezing, all right," Gus said. "But engines run hotter now than they did only a few years ago, so plain alcohol is likely to boil away. The only advantage it has over the antifreeze mixtures is that its first cost is lower—but you have to add to it so often in the course of the winter that in the end it costs you as much as the made-up mixtures, and you have a lot more bother with it."

Joe Clark's voice came from the office: "Hey, Gus. Send Harry over to the golf club with the wrecker. And Mrs. Miller says—darn that telephone!"

Gus grinned. "Time to go to work!" he said.

Ez looked at his watch. "Holy cats!" he yelled. "An' me with my mail not made up!"

"Roarless Road" of Asphalt Spares Motorists' Nerves

ROARING of tires on asphalt roads is said to be eliminated by a new kind of surfacing being tried out in Massachusetts. On a seven-mile stretch between Petersham and Barre, "pea stone" was used instead of the type of stone usually employed for surfacing. Inspectors say that the new surface is equal to the old in quality and speed, while sparing motorists the nerve-racking roar usually produced by tires on asphalt roads. If the test proves successful, the new construction plan will be widely used in future road building, it is predicted.

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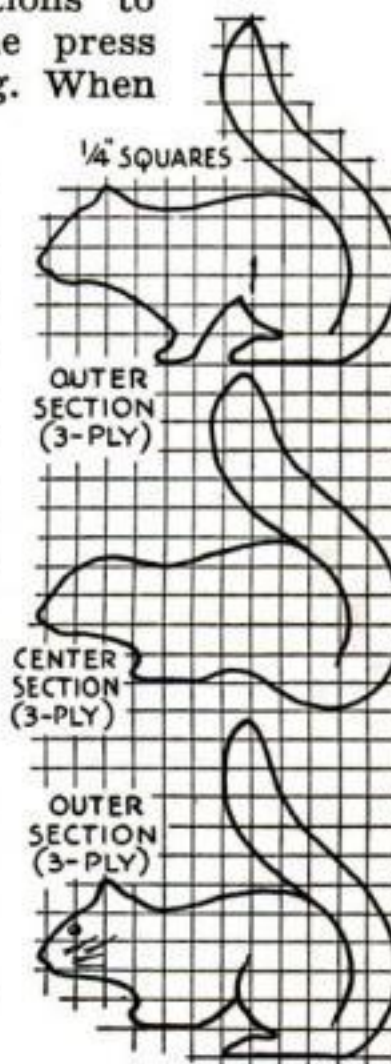


Alert Little Red Squirrel Guards Trinket Box

NATURE lovers will appreciate this trinket box upon which sits an alert red squirrel. Suitable basswood boxes can be purchased at handicraft supply houses, and they should be stained light oak to contrast with the red mahogany stain used on the squirrel.

Jig-saw the three sections of the squirrel to shape, using plywood glued up from three thicknesses of 1/8" gumwood. Join these parts with casein glue and drive small wire nails through the sections to prevent slipping in the press during overnight drying. When the nails are removed, fill the holes with crack filler. Complete the shaping, preferably with rotary wood files and dental burrs held in a chuck. Make the eyes of black glass-headed pins. When staining, leave the throat and stomach, as well as a narrow band around the eyes, in the natural wood. Use black ink for marking the mouth, nostrils, whiskers, and side stripes between the fore and hind legs.

If the box is to be used for jewelry, line the inside with felt or plush.—EDWARD B. FOX.



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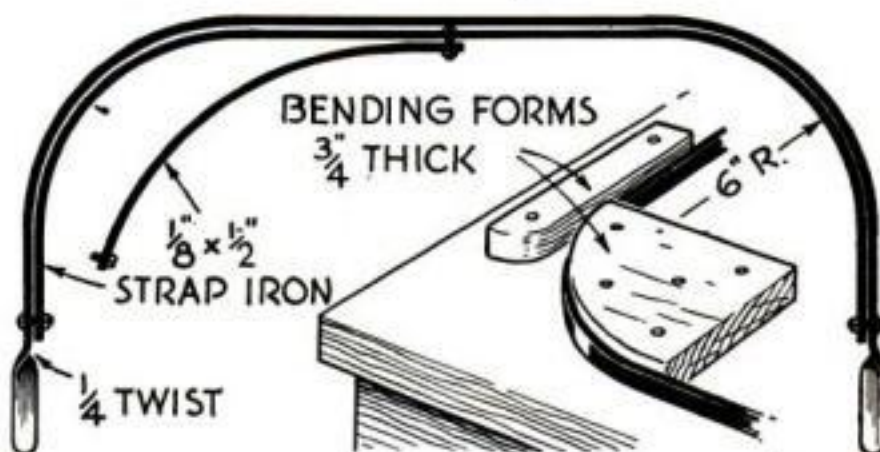


Metal Frame Lifts Bed Covers Off Invalid's Feet

ANYONE confined to bed for a long period can be made more comfortable by providing a frame to hold the bed covers up off the feet. The materials required are three pieces of 1/8" by 1/2" strap iron, one 43" long, another 37", and the third 14". The joints are fastened with 8-32 machine screws.

To enable the frame to be folded flat for storage, one end of the curved center brace is held with a short screw that projects about 3/16" as shown. When this projection is snapped into the hole at the center of the bottom piece, the whole assembly becomes rigid.

The frame is finished with a coat of aluminum paint followed by two coats of white enamel.—R. E. MATHIAS.



Three pieces of strap iron constitute the frame. Wood scraps nailed to the bench aid the bending

Lacquer Marbleizes Wall Paper

FOR about three feet up from the floor, the side walls of our kitchen were somewhat uneven and rough. I put on a plastic-effect wall paper and then brushed on linoleum lacquer, which gives an attractive marbled appearance and protects the surface from water and grease. When first applied, the lacquer appeared to have ruined the paper, but it dried beautifully. Before trying this stunt, however, it would be well to test the lacquer on a sample of the paper, as papers vary a good deal.—R. J. MCCUTCHEON.

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Now saves hours of slow, tiresome hand sawing... new light-weight Guild Cutter is 5 to 10 times faster—easy to use—cheap to run. Many uses in shop or home. Cuts compositions equally as well as wood. Grooves, dadoes. Weighs only 7 lbs., 45 degree tilting base for bevels. Depth adjustment and ripping guide. Capacity 1¼". 110v. AC-DC Motor. Write today.

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Water ballast chamber and air control valve for diving. Runs on surface or underwater. 64 parts ready to assemble. Die cast conning tower, naval gun, keel parts. 19 inch Model completely assembled in navy colors..... \$3.50 P. P.

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SEE PAGES 218-225



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SAY TO CALL?

HOW MUCH
DID I QUOTE?

WHEN IS THAT
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WHEN IS
THAT MEETING?

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AN ORDINARY claw hammer, used as shown with a combined pulling and twisting movement, makes an effective insulation remover. The wire should be held firmly in a vise or looped around a nail or piece of securely anchored wood.



The hammer is pulled and twisted simultaneously

Cup Washers for Model Work Made from Upholstery Tacks

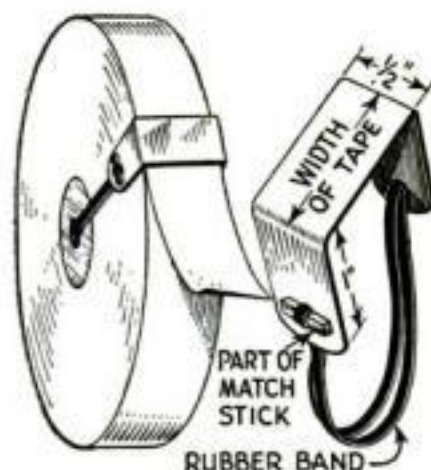
IF YOU are ever in need of small cup washers for model work or cabinetmaking, you can make them by driving brass-headed upholstery tacks into a board and filing off the tops. A very little filing will release the head from the nail, leaving a washer.



Cutter Fits on Paper-Tape Roll

CUT from a tin can, this simple device will keep a roll of adhesive paper tape from unrolling and also serve as a cutter. It is

held in place with a rubber band and two short pieces of match sticks. Be sure to press the burr or jagged edges of the two holes in the tin with a pair of pliers so the edges will not cut through the rubber band.—FRANK SHORE.



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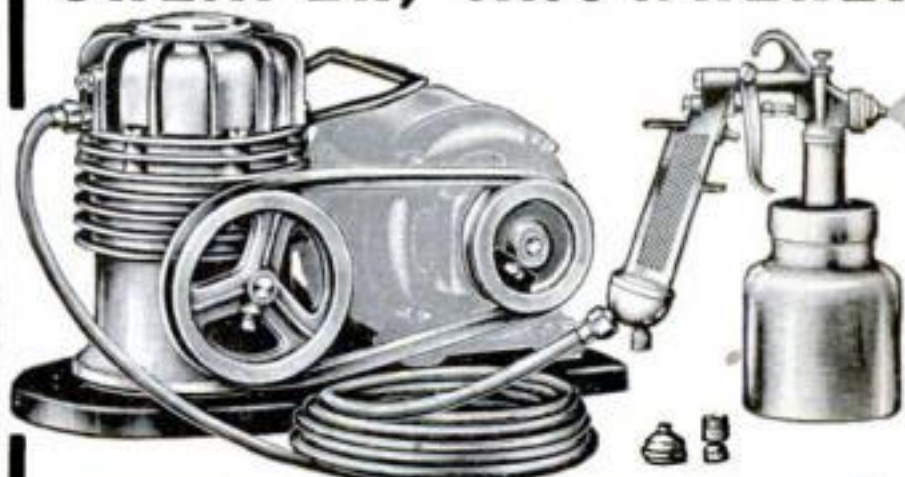
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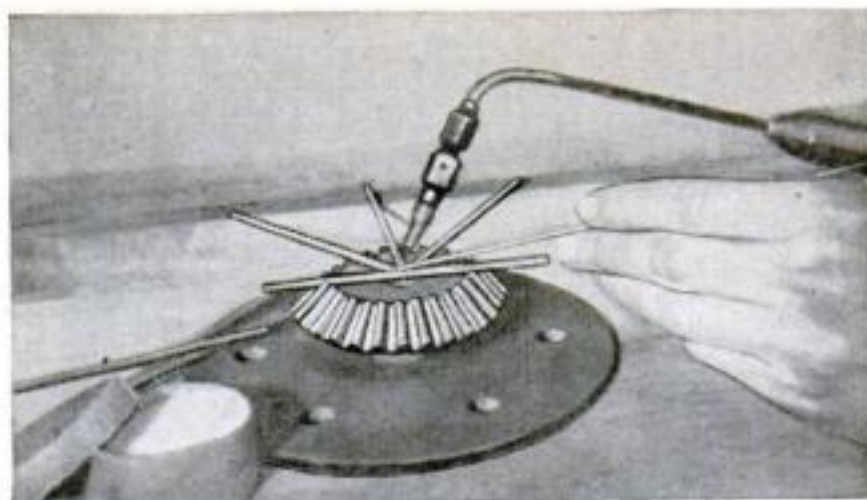
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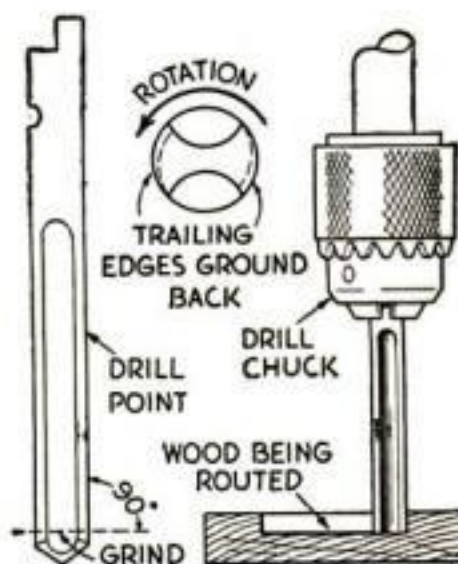


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WIRES, rods, or small tubes can be supported in practically any angular relation to each other while being brazed or welded together if an old bevel gear, screwed from underneath to a metal base, is used. The gear may have to be annealed before the screw holes are drilled.

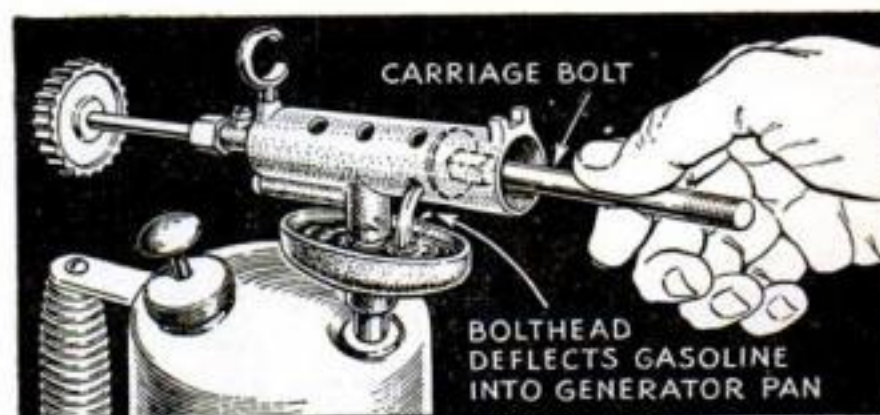
Router Bits from Drill Points

HERE is another way to beat the budget in enlarging the field of usefulness of your drill press. The larger sizes of automatic drill points can be turned into very useful router bits by the method shown. Automatic drill points are made to cut in both directions, and there is a tendency to burn the wood unless the trailing edges are ground off as indicated.—XURY R. SETTLE.



Bolt Aids in Starting Torch

WHEN starting his blowtorch, one tin-smith inserts a large roundhead bolt into the burner cylinder as shown in order to deflect the stream of raw gasoline down into the generating pan until it is filled.



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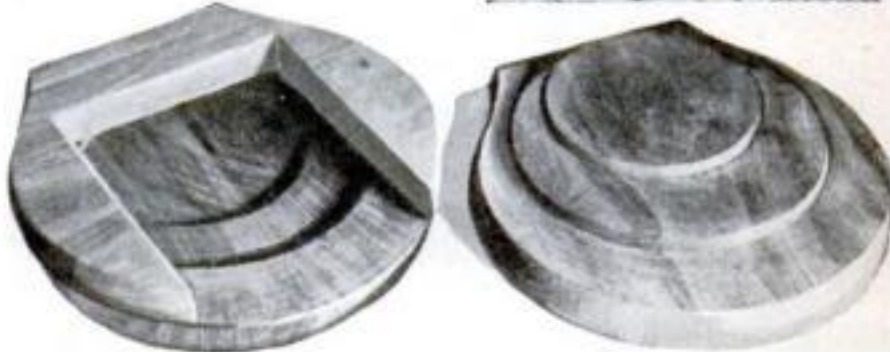
SEE PAGES 218-225



A Modernistic Flower Holder Jig-Sawed from Walnut

ONLY three pieces of $\frac{3}{4}$ " thick walnut stock are required to make this unusually beautiful modernistic cut-flower holder. With your jig saw set at a 10-deg. angle, cut two circular pieces to a diameter of 7", but leave an extension on one side of each, as shown, for the base. Keep the saw table at the same angle and cut two smaller circles from these pieces as indicated. The edges of these disks are sanded smoothly and pushed through to project as far as they will go. They are then glued in this position.

The center section or spacer is a circular piece, cut slightly larger than the two largest pieces of the front and back. From this section cut a hole $4\frac{1}{4}$ " wide and 5" deep, in which a copper water container





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AUTO COMPASS**
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ACCURATE SHOOTING

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This One



GF9L-8B7-LR5G

fits. Sand all parts to smoothness, then glue together. Finish by staining, filling, and varnishing in the usual way. Bend and solder a copper water holder to fit snugly into the recess, as shown on the preceding page.—B. B. BRONSON.

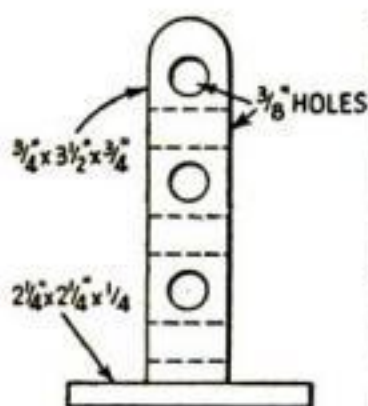
License-Badge Pin Knurled to Prevent Slipping

TO GUARD against losing a hunter's license badge, knurl the pin with a pair of pliers. This roughens the pin so that it stays in place even if unclasped.

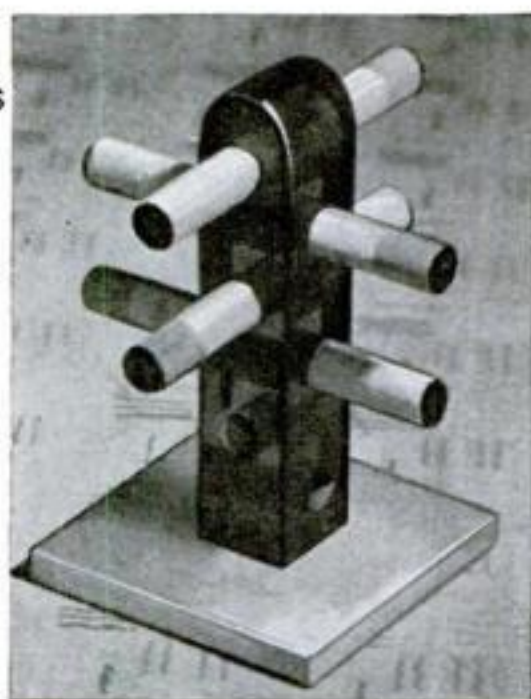


Table Cigarette Dispensers Made of Crystal Plastic

NOVEL cigarette dispensers, from which your guests may help themselves at the table, may be readily made from any crystal-like cast-resin plastic. The upright is a square rod of clear plastic of the desired color. Shape it round at the top with a jig saw, and drill six $\frac{3}{8}$ " holes in rows of three at right angles to each other, as shown. After being polished, the upright should be cemented to a base of $\frac{1}{4}$ " thick white plastic. This is another popular design prepared by the Metropolitan Junior Achievement, New York.—K. M. S.



Any crystal-like plastic may be used. The top is shaped round with a jig saw



Uses for Discarded Machine Beds

IN MOST machine shops, it pays to save a few discarded machine beds for possible use in assembling the special shopmade equipment required from time to time in order to handle unusual jobs economically.—H. C.

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Send for the latest Walker-Turner catalog today and select the gift you want to give, or the gift you want to receive. With a Walker-Turner Machine you can be sure of the finest, dollar for dollar, available today.



(Left) 24" Direct Drive Jig Saw. Patented blade tensioner reduces blade breakage and permits varying tension without stopping machine. Model MJ44 shown: \$41.50 including motor. Other models from \$13.50.



(Below) Walker-Turner model L540 Gap Bed Lathe. Ample overload capacity—both thrust and radial. Head and tail stock centers have No. 2 Morse Tapers. Price \$17.50 without motor. Other models \$37.50 up.

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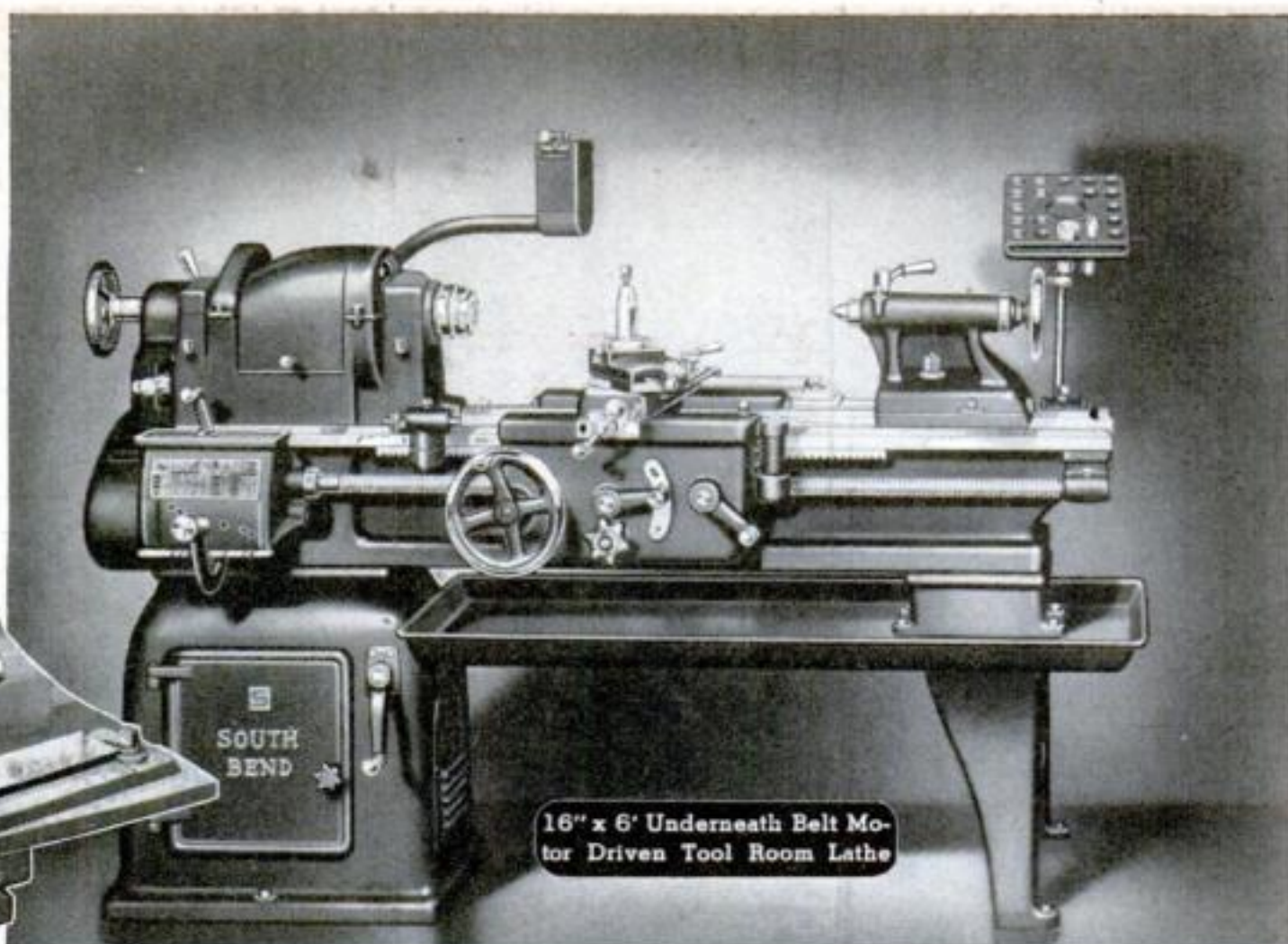
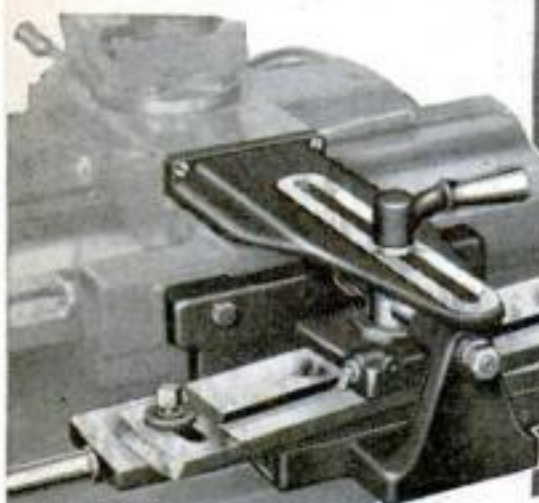
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